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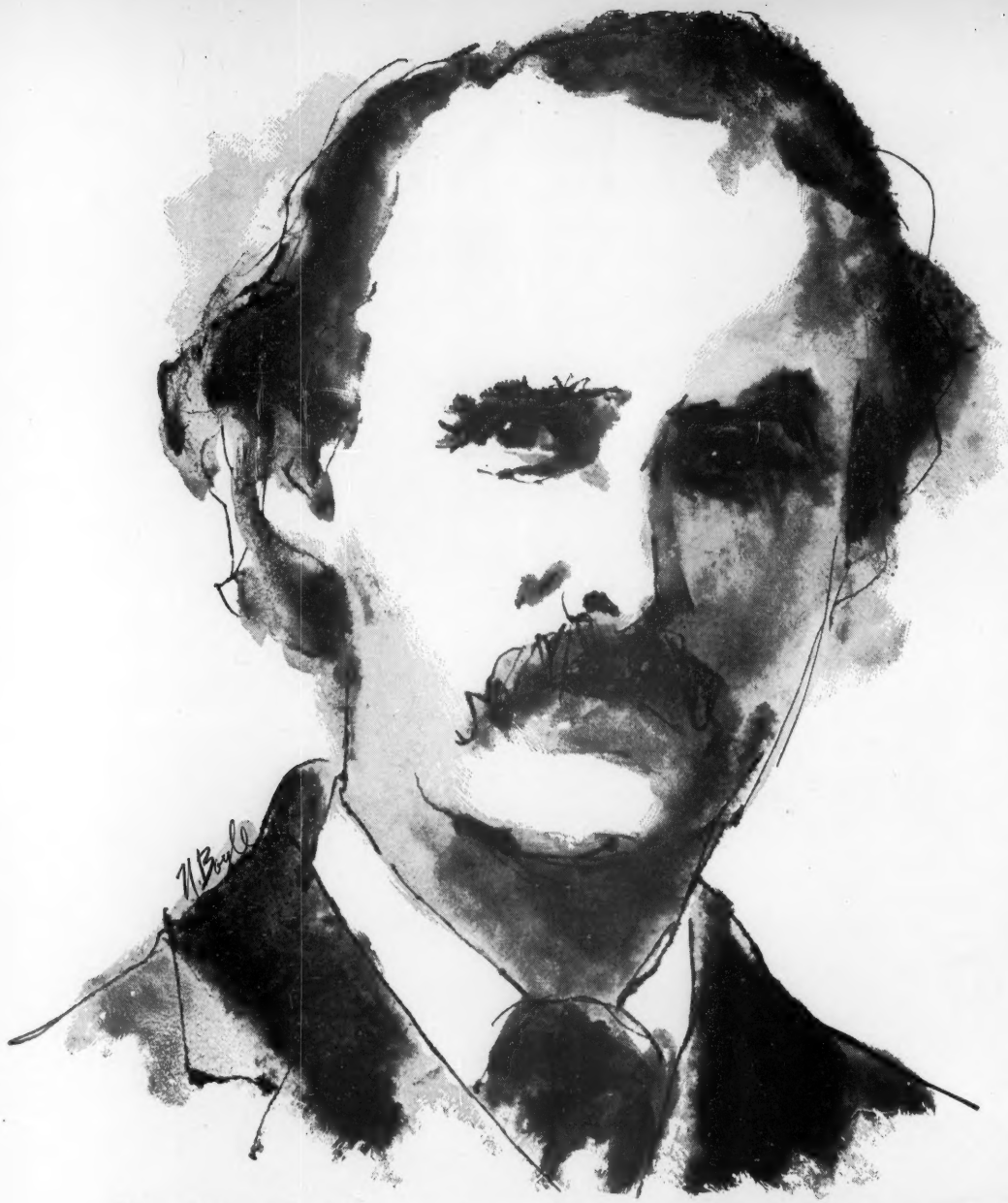

## Alfred Marshall...on the tendencies of human action

"The laws of economics are to be compared with the laws of the tides, rather than with the simple and exact law of gravitation. For the actions of men are so various and uncertain, that the best statement of tendencies, which we can make in a science of human conduct, must needs be inexact and faulty. This might be urged as a reason against making any statements at all on the subject; but that would be almost to abandon life. Life is human conduct, and the thoughts and emotions that grow up around it. By the fundamental impulses of our nature we all—high and low, learned and unlearned—are in our several degrees constantly striving to understand the courses of human action, and to shape them for our purposes, whether selfish or unselfish, whether noble or ignoble. And since we *must* form to ourselves some notions of the tendencies of human action, our choice is between forming those notions carelessly and forming them carefully. The harder the task, the greater the need for steady patient inquiry; for turning to account the experience, that has been reaped by the more advanced physical sciences; and for framing as best we can well thought-out estimates, or provisional laws, of the tendencies of human action."

—*Principles of Economics*, 1892

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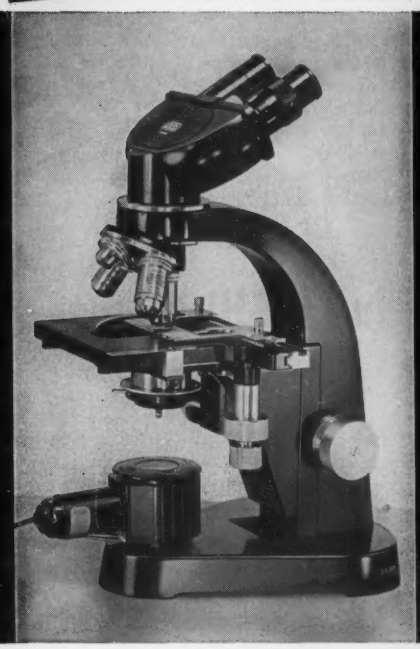

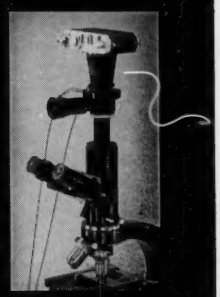

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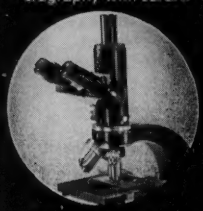

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## Countdown at Geneva

In the best of all possible worlds, the Geneva conference on the possibility of designing a workable system for monitoring nuclear explosions might close with a set of propositions about what could be accomplished scientifically under various political conditions. The propositions might state, for example, what kind of explosions could be detected by stations located outside the boundaries of the participating countries, by stations located inside those boundaries, and by an international inspectorate with free access to any area of suspected activity.

Under such conditions the degree of international freedom acceptable to the participating governments need only be specified, and everyone would know whether it was possible to ensure compliance to all, or to part, of an agreement to suspend the testing of nuclear weapons. But in the best of all possible worlds the conference would not be necessary, while in this world science does not quite fit this pattern, and neither does foreign policy.

In science there is sometimes a twilight zone of uncertainty between the definite confirmation of a proposition and the definite denial. The trouble is that just that matter for which a precise judgment is required may fall into this zone. In these circumstances we must be satisfied, if only for the present, with a situation in which one group of experts may offer one answer and another group of equally qualified experts another answer, or else a situation in which, if the experts agree on the answer, they still feel constrained to express that answer in terms of probabilities.

If scientific matters are not always clear-cut, how much less so are the implications of scientific findings for the conduct of foreign policy. In the present case, it is possible, on the one hand, for a government to fail to grasp that, even at its best, science in some areas can only offer high probabilities. The responsible administrative officials might demand such conditions of certainty as to foredoom the possibility of any monitoring system meeting those conditions. On the other hand, it is possible for a government to understand the logic of science only too well. A ruling body seeking, in a broader military or ideological context, to turn the problem of a monitored suspension of the testing of nuclear weapons to its own advantage would have plenty of room in which to maneuver.

Given a complex question, however, there is sometimes a special order for taking up the parts. To follow this order will increase the chances of coming to an agreement or, at least, of locating the sources of difference. Thus, it is helpful to settle what can be settled scientifically before going on to what must be settled politically. This is what is now being done. And we can imagine that the scientific questions themselves fall into a certain order. Thus, before considering how many inspection stations should be set up in a given system, it is proper to determine, first, from how far away bombs of a given size can be detected.

With the possibility, however, that small differences in scientific judgment may have large political consequences, something besides adherence to a rational order of business is also required—something for which adherence to that order is a first sign—namely, the desire, at least in this aspect of East-West relations, to have matters work out.—J.T.

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# Basic Research in Europe

## Different countries favor different systems for the support and organization of scientific work.

David M. Gates

Europe offers an unusual opportunity to observe the support and organization of scientific research conducted by countries differing greatly in their cultural and economic histories. We see in some European countries highly successful research organizations; in some, very brilliant individuals; and in some, very little of either. Perhaps by looking closely at these examples one can learn lessons of use in our own country. Some of the outstanding features concerning the organization and support of scientific research and the general level of scientific activity in the various European countries are discussed in this article.

The Office of Naval Research of the U.S. Navy has maintained for ten years a branch office in London which is engaged in the exchange of scientific information between America and Europe. This office is staffed primarily with university and government scientists, appointed for one or two years, who are on leave of absence from their American institutions. These men, about 15 scientists, are visiting European universities and research institutes, exchanging ideas in almost every field of science. The observations presented here represent an interpretation of the viewpoints expressed by some of these scientists and of my own personal experience.

### Great Britain

Most observers agree that the scientists of Great Britain are making first-rate contributions to all fields of science. This must indeed be evidence of good organization, of a sound educational system, and of a stimulating cultural and economic environment. In Great Britain the general responsibility for national scientific policy rests with the Lord President of the Privy Council, to whom two scientific advisory groups report: on the military side is the Defence Research Policy Committee, and on the civilian side, the Advisory Council for Scientific Policy. The DRPC is composed of the chief scientist from the Admiralty, the War Office, the Air Ministry, and the Ministry of Supply. The ACSP has a more diverse representation, from the councils for Scientific and Industrial Research, Medical Research, Agricultural Research, and Nature Conservation. The scientific policy of these councils is determined by their membership, which is composed of eminent scientists from universities and representatives of industry and labor as well. The Research Councils also make grants and award contracts for research to be done at universities and elsewhere, and give fellowships for the training of research workers at postgraduate levels. The principal government organization in Great Britain for dealing with research and its application is the Department of Scientific and Industrial Research (DSIR), under whose jurisdiction come 14 research organizations, such as the National Physical Laboratory. A number of civil departments, such as the Ministry of Power and the Home Office, have scientific staffs and a scientific adviser. Liaison between these departments and the Research Councils is close and informal.

Among the nongovernmental societies which are greatly relied upon for advice and for the dispersal of funds is the Royal Society of London, composed of about 500 fellows who are pre-eminent in the scientific community of the British Empire. A considerable endowment has been built up over the years, and the interest from this supports special professorships and research to the extent of more than $100,000 per year. In addition, the Ministries grant money through the Royal Society for certain special projects.

When Americans think of British universities they usually think of Oxford and Cambridge and are generally surprised to learn that most of Great Britain's 22 universities are more youthful than their own. Prior to 1900 there were only 12 universities in existence there. Since World War II, five new universities have received full recognition. More than 70 percent of the students receive scholarships derived from private or public funds, a situation adding considerable strength to the British educational system. The DSIR alone provides over $1.5 million per year for research scholarships.

The British universities are government-supported and are represented to the government through the University Grants Committee. This committee is the direct link with the Chancellor of the Exchequer, and establishes budgets and policies on a quinquennium basis. In general there has been sufficient money available for research, although most British professors feel that they could use more, and as a result have accepted support from American military agencies. A very few academic research projects are supported by the British military research laboratories.

One gets the impression that there is somewhat greater stability and freedom in the British system for the support of research than in the American system. In Britain the Chancellor of the Exchequer presents his budget to Parliament, usually in March, and Parliament must

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either accept or reject it in total. Rejection means a fall of the government. It is in the preparation of this budget and in making reductions in the budget that the Defense Research Policy Committee and the Advisory Council on Scientific Policy play their greatest role; all final decisions must be made by them. The amount of money available for research can be counted on from year to year so that long-range plans can be made with assurance. Manufacturers with government contracts can make their plans for a number of years in advance with the almost certain assurance that the Treasury will live up to its commitments. Greater freedom is achieved by supporting individuals and institutions per se, rather than by supporting specific projects with definite objectives, as is the case in the United States at the present time. Many research institutes and individual scientists in Britain know that so long as they are productive they will receive support on a continuing basis without having to campaign for funds each year or having to submit project proposals frequently to various agencies. Several of the 14 government institutes set up under DSIR receive funds from the military agencies but are almost completely shielded from any political pressures which might tend to divert the effort of the institute into applied research rather than basic research.

A considerable amount of university construction is taking place in Britain today, but this has not made up for the great overcrowding of the universities which took place just after the war. University salaries are low; in fact, a university scientist in Britain is relatively worse off than his counterpart in the United States. The shortage of engineers and scientists is decried everywhere, and there is some criticism of American recruiting in Britain of this precious commodity.

## Scandinavia and Finland

Considered as having the highest standard of living of any part of Europe, Scandinavia (comprised of Sweden, Norway, and Denmark) and Finland are held in very high esteem for their scientific pre-eminence. Sweden is outstanding in nearly every scientific field, and its scientific productivity is high, a factor closely related to the fact that Sweden has been successful in avoiding wars and foreign military occupations and has the greatest supply of mineral resources in Scandinavia. Denmark exhibits excellence in the biological sciences, but except for the Bohr Institute cannot be considered as outstanding in the physical sciences. Medical Sciences in Denmark are outstanding, largely because of the Carlsberg Foundation which receives its support from the Carlsberg Breweries. Norway and Finland have contributed very notably in certain narrow areas such as auroral physics, oceanography, and in dental science; however, it is difficult for these small countries to compete in quantity with the larger countries.

In Sweden one is struck by the newness and spaciousness of the academic research laboratories, which can be referred to only as ultramodern and as the finest in Europe, if not the finest in the world. Few American university laboratories are any better equipped. This is consistent with the fact that Sweden maintains the highest standard of living in Europe and has an extremely high cultural standard. Academic salaries have been raised in the last couple of years and compare favorably with those in England.

Unfortunately for Sweden, one of her greatest exports is young scientists, a situation created by the lack of opportunity within Sweden and by the strong demand in the United States. The situation is aggravated by a very rigid and formalized professorship structure within each Swedish university. A lecturer who has been at a university for seven years and has not achieved a professorship must go to another university. However, in view of the fact that at the four universities in Sweden there are usually only one or two professorships in any given field, this forces out of the country many extremely competent young scientists. In one or two exceptional instances the king has etsablished a "personal" professorship in order to retain an outstanding man. The system of training scientists and appointing faculty members in Scandinavia is considerably different from that in America, and even different from that in the rest of Europe. There are three principal degrees: *kandidat, licentiat,* and *doktor,* to be interpreted as an M.S., a poor Ph.D., and a very good Ph.D. degree, respectively. The *kandidat* degree is given after examinations have been taken in three subjects, and requires three to four years of study. To obtain the *licentiat* a substantial research paper is required, in addition to advanced study in seminars and independent study. Persons wishing to teach or do research in universities will then study for the doctoral degree, although minor positions are filled from the two lower degrees. The doctoral thesis is of book length and usually takes several years to complete. The position of docent provides the best opportunity for research. There is usually only one docent per department, and the salary is nearly as large as that of the professor. Appointments as docent are made for six or seven years and may not be renewed, which leads to the difficulty mentioned above. When a professorship becomes vacant the position is filled by competition among the docents apply-

ing, the selection being made by a committee of professors from all the Swedish universities.

The four universities are represented to the Minister of Education by the University Councillor, to whom they present their budget requirements. The Minister of Education deals directly with Parliament. Money for new buildings, university salaries, and some research comes through these channels. Additional money for research comes through the efforts of the National Councils for Natural, Technical, Medical, and Agricultural Sciences, which make their pleas to the Ministries of Education, Commerce, and Agriculture.

Research contracts are written between the professor and the council, and reports must be written at the conclusion of the research to describe the results. Any equipment built from contract funds must be made available to other universities or institutes if it is no longer required by the parent laboratory. A very thorough general planning of science in Sweden was made by various committees set up just after the war. The success with which they executed their plans for the scientific research programs in Sweden can be attributed in part to the smallness of the country and to the unanimity with which the committees could operate.

Like Scandinavia, the isolated country of Finland has a high standard of living and a great love of learning; its educational system is one of the finest in the world. Because of its strange language and its location, Finland probably has had less contact with Americans than has any other European country outside of the Iron Curtain. It has four institutions of higher learning, two privately supported and two state supported. Finland is to be all the more admired since, despite the fact that she suffered a great loss of life and property during the Russo-Finnish War and has had crushing economic obligations since then, she has paid off her World War I debts to the United States. In recognition of this, Congress passed Public Law 265 in 1949, which provided that money paid in this fashion should be put into a special account for the support of Finnish educational and scientific activities. The fund may be used for buying American books and equipment and for exchanging scientists between the two countries. At present, approximately $400,000 per year is available for this exchange. Noticeable consequences of this law are that Finland sends a greater proportion of its postgraduate students to the United States for training than does any other European country and that Finnish laboratories now have considerable American-made scientific equipment. On every hand one hears appreciation for this contribution. Seldom has American money abroad been spent more effectively. Although in most fields of research the Finnish contributions cannot be considered outstanding, in certain specific interests they have given exceptionally brilliant men to science. They are well known for their research in x-ray crystallography and in meteorology and are presently developing a good oceanographic program. Many new buildings are seen in Finland, and although at the present time these are not occupied to full capacity, there is every indication that within a few years they will be bursting with activity.

Free University of Berlin, built by the Ford Foundation.

### Germany

Germany is behind Great Britain and Sweden only because of the devastating effects of the war and of the Nazi regime. First-rate research is being done in every field except nuclear physics, bacteriology, and physiology, areas affected most strongly by the politics of the war. A great resurgence of high-level research is witnessed everywhere in Germany today. Germany is missing almost an entire generation of scientists, the age group of 35 to 50. Some positions of authority (such as professorships) are held by distinguished scientists who are now elderly and whose contacts with the many excellent younger men are not as close or always as inspirational as is necessary for the greatest productivity to be achieved. Unfortunately, another difficulty exists in Germany because some second-raters got into positions during and just prior to the war; these men are now only middle-aged and are there for many years to come. This situation is not general, and only slightly influences the general picture. There is little doubt that, barring unforeseen economic and political reverses, in another decade German science will rival Britain's in almost every field.

Since many of the German universities and research institutes were heavily damaged during the war, it has been necessary for German scientists to spend much of their time and effort during the last decade on reconstruction. Many of the great Kaiser-Wilhelm Institutes, which were located in Berlin before the war, were destroyed, and their personnel dispersed both west and east. The Kaiser-Wilhelm Institutes have been reformulated under the Max Planck Gesellschaft, and many of them have been relocated at university cities in western Germany. Today there are more than forty of the Max Planck Institutes and another dozen or more under the Kaiser-Wilhelm designation in Berlin-Dahlem in the American zone. These institutes receive their support from the states of Western Germany.

Much of the scientific research in Ger-

many is supported by the Deutsche Forschungsgemeinschaft, which has its headquarters at Bad-Godesberg, near Bonn. This association receives its money from both the government and industry. Membership is comprised of advisers for each field, selected from among the university professors throughout Germany. These committees then pass on the requests for grants from the various universities. Usually rather definite areas of research are supported by the Deutsche Forschungsgemeinschaft; however, the grants are usually given to an institute rather than to individuals. The universities in Germany are state supported, and since some states pay more than others, it is difficult to attract good people to the more poorly paid universities. In contrast to England, there are no fellowships or scholarships for students, and so most students must either come from well-to-do homes or work their way through the university. One state, Hesse, offers a free university education to any student resident in that state who can pass the entrance examination.

Several new German universities have been established since the war, such as the Free University in Western Berlin, which has received a great deal of Ford Foundation support, and the Johannes Gutenberg University in Mainz. In addition, one observes a burst of activity in certain localities. The University of Bonn, which formerly had no tradition whatever in physics or, particularly, nuclear physics, during the last couple of years has received a large sum for establishing two institutes: an institute of physics and an institute of nuclear physics. The latter is starting an extensive building program of laboratories, offices, classrooms, and a 70-Mev synchrotron, the total cost to be about $1.5 million. The physics institute is building a 500-Mev electron synchrotron which is to cost at least as much. In the near future, the University of Bonn will be the best equipped of the German universities for nuclear physics. The funds come from the highly industrialized state of North Westphalia. Other departments in this university are doing nearly as well. Controlled fusion research is being done at Göttingen, Aachen, Munich, and Hamburg.

At the Munich universities alone there are more than 70 inorganic chemists, and it is felt by some that research in synthetic inorganic chemistry is proportionately greater in German universities than it is in the United States. In fluid mechanics, Germany is the country in Europe best organized to carry out basic research. This is done primarily at the *Technische Hochschulen,* which are state supported, at which are located the private research laboratories of some of the professional societies. The situation in the field of solid-state physics is discouraging and reflects all the ills characterizing Germany as a whole. On the other hand, the Siemens industrial laboratories are among the best in Europe.

One sees throughout Germany most departments capably directed by a senior staff and the work enthusiastically developed by the junior scientists and students. In the smaller departments, a single professor may still do all the lecturing and younger men may wait many years for a professorship. Furthermore, one must take special examinations in addition to the Ph.D. degree in order to lecture at a German university. Although there has been a tremendous resurgence of science in Germany, the Germans are still hampered by an inflexible professorial system which has not met the changing demands of recent times. One can say in general that scientific research is adequately supported in Germany today by the federal and state governments, and that industry is making a sizable contribution. The great efforts made by American foundations and by the U.S. Government in collaboration with the German Government during the last ten years have gone a long way toward resurrecting in Germany a healthy intellectual environment.

Meteorological Service Building at de Bilt, Netherlands.

## Netherlands

Scientific research in the Netherlands can be typified by the word *quality* rather than *quantity,* and the excellence of the work reflects a high degree of organization and a well-conceived educational system. The Dutch have had to work hard for everything they have, and their obstinacy and perseverance have shown up in an individualism which is unique in Europe. It has often been said that one Dutchman is an individual, two are a committee, and three are an organization. The Netherlands is the equal of Sweden and Germany in the physical sciences, may fall slightly behind in the biological area, and is first rate in psychological research. The Dutch suffered severely in the war and lost heavily in scientific manpower and equipment. It is indeed remarkable that today one scarcely notices the effects of that catastrophe.

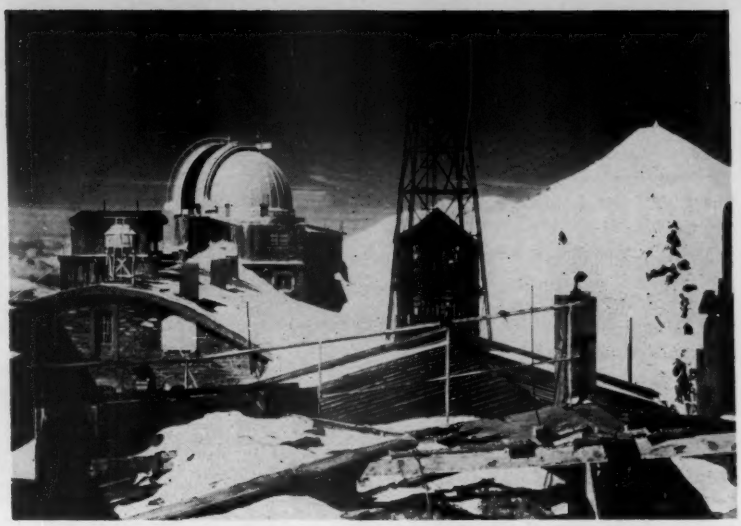
Dutch science can best be typified as a melding of the basic and the applied; it exhibits great individualism and at the same time skillful planning and organization. To exemplify this one need only mention the Philips Research Laboratory, the Kamerlingh Onnes Laboratory, and the Technical University at Delft. The nuclear physics laboratory at Utrecht is run on a five-year plan which is revised every year. The physics department is expertly run through committees, and, in addition, one member of the staff acts as business manager.

Research work in the Netherlands

has been more or less tailored to the needs of the country. The Dutch have been famous for their work in hydraulics, in geodesy, in seismology, in botany (stemming from their plantations in the East Indies), in agriculture, in cyogenics, and in statistical mechanics, and since the war they have been working on the peaceful applications of nuclear energy. Their university laboratories are overcrowded and they decry a lack of trained personnel. Their newer laboratories are elaborately designed to reduce the need for technicians. The lack of scientists stems from the rigors of the Dutch system of education.

There are nine universities and technical high schools in the Netherlands, located in Amsterdam, Rotterdam, Leiden, Utrecht, Delft, Groningen, Nijmegen, and Wageningen. Several of the state universities were founded in the 16th and 17th centuries, while the technical universities were started at the beginning of this century. Though one sees numerous old buildings on each campus, the number of structures erected since the war is impressive. The universities are supported locally by their municipality or state and have an average enrollment of about 5000 students, with a three-to-one ratio of men to women. Students graduating from secondary school are admitted to the university by examination. Often after the first or second year further oral examinations are required. After the bachelor's degree, about three years may be spent in graduate study which culminates in a comprehensive examination. The industries are happy to employ people at this stage, and so, partly for this reason, and partly because of selectivity, only a few students proceed beyond this point to get the Ph.D. The Ph.D. thesis usually takes another three to four years, and so the total time spent in graduate work may amount to six or seven years. The Ph.D. thesis is much more elaborate than the American one, so the recipient of a Dutch Ph.D. may be considered as having had considerably more experience. These factors, along with the possibility of two years of military service, tend to restrict severely the number of Ph.D. candidates. The situation is further aggravated by the fact that industry pays salaries at least 50 percent higher than the universities do.

The result of this system is that in most academic laboratories one finds a professor at the head of an organization containing from 30 to 150 people. The professor will therefore have considerable administrative work within his own department. The academic pyramid is well filled at the very bottom with large numbers of graduate students, but there are too few people in the intermediate ranks between the Ph.D. degree and the full professorship.



Observatory at Pic du Midi, Haute Provence, France.

A number of scientific research institutes which conduct research in almost all fields of science are active. The most noted of these institutes is the Central Council for Applied Scientific Research in the Netherlands, T.N.O. (Nederlandse Centrale Organisatie), located at The Hague, and organized in 1932. This organization has five branches which function as national research councils for industrial, nutritional, health, agricultural, and defense research. There are specific institutes working on programs in each area at the main laboratory at The Hague.

Basic research in the universities is supported through the Foundation for Fundamental Research of Matter and by the Netherlands Organization for Pure Research, Z.W.O. (Stichting voor zuiver Wetenschappelijk Onderzoek i.o.). These agencies are government-supported but receive substantial contributions from industry as well.

## France

Most visitors to France agree that the potential of the country for research is considerably greater than her productivity. France is a dilemma and a bit difficult to analyze. Science in France exhibits towering individualism, inspired ideas, and localized brilliance, but seldom reflects a large coordinated program involving teamwork. Three factors have probably contributed most strongly to the fact that French science is not more enlivened today than it is: the overly idealistic approach to the organization of scientific research which took place between the two world wars, the virtual isolation of France by occupation during World War II, and a rather inflexible but highly respected educational system with a great tradition for the arts and literature. French science today lacks adequate support by one or two orders of magnitude. This is a bit surprising when one considers that French scientists have enjoyed positions of great political and social prestige, more so than in almost any other country. France did not receive the stimulus of the war which led to the great cooperative efforts between basic and applied research which took place in the United States and Britain and which have rallied support for science in these countries ever since. Basically, the difficulty in France is an economic anemia resulting from the following factors: (i) wars have drained France of personnel and of scientific and industrial materials; (ii) France is an agricultural country of peasant proprietorship; (iii) for France, Paris is the hub of the universe and acts as an economic drain on the rest of the country.

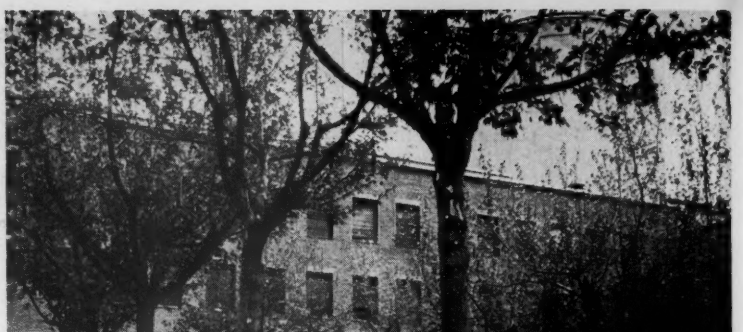
French science is organized under the Centre National de la Recherche Scientifique. The council of CNRS is ad-

mirably constituted, being composed of several hundred scientists who have distinguished themselves by recent research and who must continue to engage in research. CNRS has a representative on the Commission for the Planning of National Expenditure, which reports directly to the Minister of Finance. Within the CNRS the decisions of the council are carried out by an executive committee which can plan research on a national basis.

One notices in France, more than in any other country, that the scientific laboratories are housed in ancient buildings, remnants of a glorious past. Academic salaries are desperately low, and as a result many scientists must hold more than one job in order to earn a living. For a number of years there were large inequalities between the salaries paid by the Ministry of Education and those paid for professorships by CNRS. This situation has been somewhat corrected in recent years.

Despite the good intentions of CNRS, French science seems to be rampant with personal enmities which are severely retarding its growth, with a neglect, conscious or otherwise, of the provincial universities, and with an overemphasis of some fields at the expense of others. The strong personal feelings may be the result of a rather volatile sociological and political system which allows opinions to be expressed without fear of persecution or ostracism. This is a freedom which has considerably wider bounds in England and France that it has had in America since World War II. Another difficulty is exemplified by the procedure for the appointment of professors at the Sorbonne. Each candidate must have a personal interview with every member of the faculty, an interminable procedure, since there are several hundred faculty members. This procedure also is used for election to the French Academy of Sciences.

The French university faculty organization is still based on the patron system, the professor being responsible for all of those under him and usually dictating the program of research his disciples will follow. This is not solely a French affliction but is a general European characteristic. A departmental staff may consist of a professor, who may or may not teach, an assistant professor, a *maître de conférence* who does most of the teaching and who is held in great esteem, a *chargé de cours* who is not an official member of the faculty, and, finally, laboratory assistants who are entirely involved with research and study. In France, university courses usually are taken without credit, and one's recognition and position come from the esteem in which he is held by his colleagues, based upon knowledge and research productivity. The universities are primarily supported by the national government through the Ministry of Education, which, at the operating level, is reasonably free of the vagaries of French politics.



Institute of Optics, University of Madrid, Spain.

Thinking of French science, one is reminded of the brilliant contributions which have been made to optics, to the study of the night sky, to solar and radio astronomy, to electronics (traveling-wave tubes, carcinotrons, and photomultipliers), to the bathyscaphe for oceanography, to magnetism, to radioactivity, to tropical-disease research, to immunization, and to psychology. From an engineering standpoint, the French system for the distribution of electricity over the country is one of the best. In most cases these are examples of brilliant individual contributions with little mass effort in evidence. Often interest in a subject will wane when its leading scientist dies. Probably the most enviable characteristic of French science is the ability to develop towering individualism and great imagination, a characteristic we must encourage in America.

## Italy

Although a creditable amount of excellent research is being done in Italy, there are certain circumstances which tend to reduce the research productivity of Italian laboratories. The universities generally derive support from state and local funds, and money for research from these sources is virtually nonexistent. Research is supported by the Federal Government through such agencies as the National Research Council or the National Institute for Nuclear Physics. The government has set up numerous research centers at universities specializing in different subjects, and much of the notable research is being done at these universities.

Several factors work toward diluting the quality of Italian research; among these are low academic salaries, heavy teaching duties, multiple jobs, large classes (300 to 800 not uncommon) without laboratory work, a doctorate degree the equivalent of a good American master's degree, inadequate research experience in work for degrees, free and easy publication, the existence of too many journals of inadequate standards, the acceptance of quantity rather than quality in publication, and the environment of a country steeped in the cultural traditions of the arts, with little appreciation for the importance of science to modern life. It is generally expected that a good percentage of those getting doctor's degrees will emigrate. A good deal of fine scientific equipment has been supplied to Italy through the Marshall Plan, and the Italian government is making a concerted effort to develop good schools of science throughout the country. Italy is doing first-class work in nuclear physics and in chemical physics, but cannot be regarded quite so highly in most other fields.

## Spain

On visiting Spain, one sees some elegant new laboratories and new equipment, but few results. Research funds are controlled largely through the Superior Council for Scientific Research under the Ministry of Education and are distributed to academic institutes in all fields of science, except agriculture. The major disciplines are grouped together into eight foundations, each of which is named after a famous Spanish scientist. Under each foundation come a number of institutes, each of which may be a laboratory but is more likely to be an administrative title to include a number of independent research laboratories.

Research in Spain is beset with many difficulties attributable in part to the poverty of the country. Salaries are low, trained personnel are scarce, outstanding laboratories are rare, teaching loads are heavy, scientific leadership and stimulation are limited, equipment and supplies must be imported, and maintenance and repairs of equipment are difficult. Unfortunately, the situation tends to perpetuate itself. Many of the more imaginative, ambitious, or talented individuals tend to leave the country. There are, however, a few gifted, devoted scientists who are able to make significant contributions.

Because of the low salaries it is customary for most of the academic staff to hold additional jobs. It is very difficult, even at the research institutes, to convince the technical personnel that their job there should receive their sole attention and that they should not try to hold down a second job in the afternoon or evening. This makes it all the more difficult to convince younger scientists that they should dedicate all of their time to research.

## Other Countries

Switzerland is somewhat self-contradictory. It is a country of magnificent industrialization but of relatively poor support for basic research in the universities.

Belgium, although good in many areas, is not of first rank in many, although again a few individuals are outstanding.

Yugoslavia is desperately poor, struggling under the handicap of a dictatorship and exhibiting the absence of free enterprise. Here again salaries are so low that almost all of the younger scientists must hold two jobs in order to earn a living. University enrollments in Yugoslavia are somewhat fictitious, since many students enroll, but do not attend classes, in order to permit their fathers to receive the government subsidy which is paid to heads of families with children in the universities. Class sizes tend to be extremely large. It is truly a tribute to some of the devoted scientists in Yugoslavia to see them fighting all odds to build within a system of restricted freedom the type of institution they know in their hearts they must have.

University of Coimbra, Portugal.

Eire is an overpopulated, tragically poor agricultural country with a total lack of organization for research. In the shadow of Great Britain it is a little surprising that more cross fertilization and inspiration have not taken place.

Israel is diametrically opposite, and is the prime example of what an energetic, prosperous, and organized people can do in what is otherwise regarded as an area devoid of scientific achievement.

Science in Austria is tremendously handicapped economically, and although there are many excellent individuals, the country has suffered from virtual isolation since the war.

Eastern Germany also has been in isolation, but has responded somewhat differently. Although it has received no help from the U.S.S.R., and little aid from the West, the momentum of the great tradition in German science has given inspiration through these politically difficult years. In many instances one sees instruments developed in East Germany which are totally unlike those used for the same purpose elsewhere, and which represent the product of truly independent thinking.

Portugal has many of Spain's difficulties in scientific research, but has one considerable advantage. The advantage is the benevolent dictatorship under a constitutional monarchy which allows in Portugal far greater freedom and communication with the outside than will ever be possible under the present regime in Spain.

## Comparisons

Perhaps one can learn some valuable lessons to apply in our own country from these observations on others. This is not to say that the European system is to be recommended, or that ours is not good, but it is hoped that we might glean some ideas from the best in theirs in order to add to ours, to achieve the most productive and inspirational research and educational program possible. The following remarks do not always apply throughout Europe, but describe the best features observed in certain specific instances.

In Europe generally, research funds are not project funds but rather institutional funds to be used for research in a broad area. This is an important freedom of action which should be encouraged in America. It greatly reduces the inefficiency of having to make individual detailed proposals and often repeated pleas for support, and of having to submit quarterly progress reports, rather than allowing published results to suffice. The inefficiency associated with project support is often appalling.

Research programs in Europe are

usually thoroughly planned and well conceived before a great effort is expended. This is a situation somewhat enforced by necessity from the more austere budgets in general and by the fact that what is done must be well done in order that further support be forthcoming. The overriding criterion for continued institutional support is probably excellence of work. In the places where really great research is being done the scientists seem to be able to be less concerned with politicking, a disease somewhat associated with project funding.

The teaching load in European universities is usually very light. This allows the scientist the opportunity to do research in a less harried atmosphere. Many American teaching loads are from four to twelve times greater than European and are considerably more arduous per hour. In Europe, examinations are less frequent and are likely to be supervised by only a fraction of the staff, thereby freeing the others for research during these hours. The important point is that in some of the best European universities the scientist is given the greatest possible amount of undisturbed research time, and this time is jealously guarded against any encroachments.

The European science student has been forced by necessity to do more for himself in the way of building up equipment. Certain countries prefer sending their students to Europe for training rather than to the United States because they feel that the students will return home with more fully developed skills than then would acquire here, where they would become accustomed to manufactured equipment. In a country where industrial equipment is available there are advantages in not building everything, and using this time for more productive research. In the underdeveloped regions of the world it is best to have people who can build their own equipment.

The availability of a large number of fellowships in England has had a notable effect on science education and research in that country. This is particularly true at the postgraduate level, where a limited number of students are supported to do research for three to four years without any other obligations to distract their attention. This does a great deal toward giving a good young scientist the momentum he needs for the years ahead in his chosen career. At some European universities this scheme is further developed by appointing exceptional postgraduates to special research positions with a tenure of five years. The results at some institutions have been clearly recognizable in terms of Nobel Prizes and other outstanding awards.

In some of the larger European universities, the professor, as head of the department, has an administrative assistant who takes many of the burdens from his shoulders, by dealing with the scheduling of courses, showing visitors through the laboratories, preparing the budget, and so forth, thereby giving the professor more time for research. In a few European universities each faculty member has a full-time research assistant who is a regular member of the staff. If one suggests that in America teaching loads can't be reduced, that assistants can's be hired, that post graduate fellowships can't be given, there is only a look of incredulity on the face of the European, who remarks: "but America is the richest country in the world!"

One knows that if one were to hire a graduate Ph.D. scientist from some of the European countries one would be extremely unlikely to get a poor product. From a few countries it would be difficult to get an outstanding graduate, not because of a lack of intellect, but because of a deficiency in training. In America the situation is far from uniform. The greatest disadvantage of European graduate programs is the nearly total lack of an organized curriculum, whereas in America we do a great deal in graduate school to make up for an accumulated deficiency in training throughout the secondary and primary schools. For the scientist in America, the deficiency in the arts and humanities is never made up. This should be an important sobering thought to our educators.

Another valuable observation would be the fact that certain geographically small countries, such as England, Sweden and Holland, may well be proud of their distinguished records in science. One wonders whether this situation results in part from the fact that the universities in these countries are few enough in number that they can plan coherently. The needs and interests of all universities can be considered when plans and budgets are made.

In America, with many universities spread over a vast area, it is far more difficult to achieve coherency. Although it is contrary to the current trend toward more federal support for education and science, it should be considered whether or not greater regional or state support is the more desirable thing. This is being done to some extent in such groups as the agricultural experiment stations, certain cooperative nuclear research projects, and so forth, but there is need for a great deal more of this cooperative type of effort. It would indeed be a stroke of wisdom if some of our state legislatures would support to the hilt certain local research institutes in a definite area of research, without the term *project funds* being mentioned and without the need for federal subsidy. The practical solution is probably a combination of both federal and state support.

The scheme in Great Britain for planning of budgets on a quinquennial basis has notable advantages and more inherent stability than the American system. This is probably related to a rather fundamental difference between the constitutions of the two countries, and our system is one that we have to live with. The on-again, off-again support of research in America is a situation which would be extremely unlikely to occur in Britain.

It is difficult to escape the observation that tradition is an extremely important motivating factor in yielding great achievements in academic research. At the same time, tradition can retard progress. This is particularly true with regard to the inflexible faculty organization within the European universities, whereby there may be a single professor in a department who is overlord of all research and instruction within that department. Young men frequently must wait many years before they can teach or receive an appointment with tenure in the university.

## Summary

Europe, traditionally the breeding ground for basic scientific research until the 1930's, is only now approaching full recovery from the devastating effects of the war. Great Britain has a more stimulating climate for research, a more progressive graduate-school program, and a more flexible professorship structure than any other country of Europe. Germany still has several years to go before the effects of the war will be obliterated. In most northern European countries, the organization and support of academic research ranges from good to excellent, and a stimulating intellectual atmosphere exists. Germany is rapidly contending for the lead in basic research

along with England and Sweden, which are now in the forefront. The Netherlands is typified by superb organization, and most of the Scandinavian countries are high in quality if not always in quantity of research. France is characterized by brilliant individual contributions but over-all falls far short of her potential for scientific research. Switzerland, a highly industrialized country, is geared primarily for engineering and does not compete as highly on basic research as might otherwise be expected. Italian research is good in certain areas but is plagued by a number of difficulties that retard progress. Nevertheless, there are encouraging efforts being made in Italy to develop some good scientific programs. In the south of Europe the situation is generally discouraging and will continue to be so, except where a few dedicated, brilliant individuals are making good contributions with the meager resources available.

Europe will continue to be a tremendous scientific manpower reserve for the United States, and, despite accusations of proselyting, the fact remains that in many European countries the employment possibilities are not commensurate with the production rate of scientists and engineers. If the universities of Europe would realign the professional structure of their departmental staffs and extend their graduate curricula they would give far more opportunity to young research scientists and make better use of their facilities. America can indeed be grateful to Europe for a great cultural and academic heritage, and one can sincerely hope that close cooperation in science will take place for many years to come.

**Note**

**This article is not an expression of the official views of the Office of Naval Research.**

# What Is the Economist's Task?

## The current recession illustrates his responsibilities as an analyst and as an adviser on public measures.

Gerhard Colm

"The proper attitude in which any economist should review this year's [economic] survey is one of humility towards the failures of his own science" [*Economist* (5 Apr. 1958)].

We have been in a recession for about six months. Although the downward movement has tapered off, signs of a sustained recovery to a satisfactorily high level of activity are not yet in sight. During the last decade most economists have emphasized that the American economy has not become immune to economic fluctuations. They have also emphasized, however, that we now have the legislative and executive machinery established by the Employment Act of 1946 and the know-how to counteract a recession, or at least to prevent a recession from deteriorating into a depression. Are we economists then to blame for the unfavorable economic developments of the last six months? Must we accept the criticism expressed in the quotation from the *Economist*? Or should our defense be that as economists we have a responsibility only for good economic analysis and that the determination of policy is the responsibility of the decision makers, inside and outside the Government? My answer is that the function of the economist extends beyond pure analysis, that the economist can and must contribute to the economic decision-making process. An economist who has been asked to advise a statesman on economic policy cannot confine himself to presenting the findings of pure analysis. For if he does, unintentionally he may give not pure but poor advice.

In this discussion I will examine the relationship of economic research to the current recession problem and to the policy measures which have been or should be taken. In this way we will be better able to judge the responsibility of the economists and politicians for the unsatisfactory economic developments which have been taking place.

In analyzing the multiple role of the economist, I will elaborate a distinction which was suggested by a remark of Edwin Nourse in his book *Economics in the Public Service*.

The economist has to consider a problem such as the recession on four different planes—namely, the planes of (i) economic analysis; (ii) institutional economics or economic engineering; (iii) economic politics; and (iv) economic statesmanship. Let me discuss each of these functions, using the recession problem as an illustration.

### Economic Analysis

The economic analysis of the recession, like the analysis of a disease, has three aspects—namely, an analysis of the causes which brought the disease about; a prediction of the likely course of events, assuming that no special cure is administered; and a prediction of the influence which various possible medications could have in promoting recovery.

*Causal analysis.* An enormous amount of research work has been done, both on an empirical and on a theoretical level, to discover whether or not there is one typical cause of economic fluctuations. If there is a single economic virus which disturbs economic growth and stability, it is elusive indeed and changes its appearance from one economic epidemic to the next. In the present case it was pointed out early last year that the productive capacity of agriculture and industry was growing faster than the aggregate demand for agricultural and industrial products in real terms. This led to growing idle capacity and made it likely that business would reduce future expansion in plant and equipment. In addition to this most fundamental cause of the recession there were a number of contributing factors, such as a curtailment in defense orders, a drop in exports due to world-wide dollar shortages,

**The author is on the staff of the National Planning Association, Washington, D.C. This article is based on an address which he presented before the Graduate Council of George Washington University, 12 May 1958.**

and the effect of a prolonged restrictive credit policy.

*Prediction.* In giving advice on policy it is essential for the economist to make a prediction of the likely course of events —assuming that no specific antirecession measures will be adopted. Is a recovery of the market forces around the corner, or is a further contraction of business activities or a sidewise movement more likely?

Many techniques for economic prediction have been tried. During the 1920's there flourished the art of devising economic barometers. Attempts were made to discover constellations of economic data which, according to past experience, indicated that an upswing or downswing was in the offing. These barometers failed so utterly in predicting the depression of the 1930's that they were thoroughly discredited and at least temporarily discarded. Yet, using different methods, the National Bureau of Economic Research has identified certain economic symptoms which typically lead, and others which typically follow, fluctuations in economic activities. This approach to economic forecasting has recently been refined by the use of high-speed electronic computers. It is reported that the President's Council of Economic Advisors has been using these refined economic barometers—always in conjunction with other available information.

Another method, at least for short-run prediction, uses an economic *prediction model,* either in a mathematical or in a quasi-mathematical form. This model takes as a point of departure present economic decisions which affect future economic events. Businessmen make at least tentative decisions on programs for expansion of plant and equipment a considerable time before the programs are executed. Governments usually decide on their expenditure and revenue programs long in advance. Consumers deliberate for some time before they buy a new house or a new automobile. Thus, surveys of business and consumer intentions and a study of government budget proposals give some indication of probable future events. On the basis of past experience, relationships are computed between those economic factors for which some present information regarding future action is available and those factors for which no such information is available. A predictive model of the economy is thus constructed, the results of the various intention surveys and the proposed budget being used as building blocks, and the relationships of the past, as binding material.

The advantage of this approach is that a prediction model is constructed solely on the basis of ascertainable current facts and economic relationships of the past. It is limited by the fact that economic relationships are not always constant, so that there exists a considerable margin of error, and also by the fact that present decisions can be changed.

Future economic events are always determined in part by decisions of the past, but these decisions are modified in response to the unfolding economic events. This is what I call the "feedback effect" in economic development. For example, prediction models which were built late last fall for 1958 showed contractions in business investments, residential building, and exports; in part these were offset by rising outlays of state and local governments. On this basis a prediction of a sidewise movement, or of a very slight downward movement, of economic activity was indicated. Anticipation of this not too favorable course of events induced business to curtail production, in several lines drastically, in order to reduce inventories. Also, consumers showed more caution in their buying, particularly of durable goods, than was indicated by surveys taken in the summer of 1957.

We have no quantitative data from past experience for building those feedback effects into an econometric model for the future. Even if we had data for the past we could not assume that the same effects would result in the future. These effects are influenced at least in part by "learning from past experience," which makes it unlikely that the reactions will remain the same. Still, it is possible, at least in a qualitative manner, to take these feedback effects into consideration. Moreover, it appears prudent to assume that these kinds of feedback effects will accentuate either an upward or a downward movement. Even if the prediction model shows no change in the general direction of economic development, the feedback effect cannot be neglected.

Prediction becomes even more uncertain if we take into account what may be called "counterfeedback" effects. Such effects include not only factors which aggravate an economic trend but also factors which mitigate or even possibly reverse it. The classical (but unfortunately largely unrealistic) case is a recession in which prices drop so that consumers will be more inclined to buy, or in which lower interest rates induce business to increase outlays. If the counterfeedback effects could be assumed to be stronger than the feedback effects, one could expect an automatic reversal of the contraction. Actually, the feedback effects aggravating the downswing usually work faster than the automatic counterfeedback effects. That is why antirecession or recovery programs are designed to strengthen the automatic counterfeedback effects. In the present situation the most important counterfeedback factors are the countermeasures which could be adopted by the Government and the Central Bank in response to an unfolding recession. Here we have no precedents to guide the prediction because the response in each case will depend on specific political circumstances and will, in part, be influenced by the experience of the last downswing. Due to the feedback and counterfeedback effects in economics, we may apply Heisenberg's "uncertainty principle" to economics. I can assure you that the behavior of the private and public decision makers in the economy is at least as elusive as the subatomic particle which puzzled Heisenberg.

Fortunately, we do not need to guess what antirecession measures will be taken because our prediction model assumes continuation of present policies. Only thereby can the prediction model help us in determining what, if any, antirecession measures will be needed.

Let us assume that a present prediction model would indicate that we can expect an approximately sidewise movement of economic activity for the rest of the year. At the same time, additions to the labor force and continued improvements in production methods and technology would increase the productive capacity available to the economy under approximately full-employment conditions. The difference between the production potential and the predicted actual production for 1958 measures the gap which a fully successful economic policy would close. A rough estimate indicates that this difference is $25 to $35 billion.

*Decision model.* The next step, then, is to construct a decision model, which is a tool for finding what kind of policies or what combination of policies could accomplish this job. The decision model would be designed to answer the question: What monetary and credit policies, or what increase in government expenditures, or what reduction in taxes, or what combination of all these and other policies could generate enough additional consumer demand or business

investment, or both, so that the total of additional public and private demand would approximately close the gap? Under present circumstances, one might, for example, reach the conclusion that a relaxation of credit plus an increase in government expenditures of $10 billion, or a tax reduction of $13 billion, or a combination of credit relaxation plus a $5 billion increase in expenditures plus a tax reduction of $7 billion might do the job. Unfortunately, very little is known about the quantitative effect of various policies, particularly of tax reduction, so that, at best, statements can be made only about a general order of magnitude.

The basic approach to the formulation of a program for use both in a prediction model and in a decision model was explicitly provided for in the original Full Employment Bill of 1945. It is still embedded, though in more general language, in the Employment Act of 1946. J. Tinbergen has given the clearest expression to the relationship between the two steps, which must be used in combination. In the prediction model, according to him, we regard policies as given and the economic result as the variable. In the decision model we posit a certain result (economic target or objective) and regard as variables the policies needed to accomplish the objective.

This technique can at best give certain alternative policies for consideration but no definite answer about the best policy. This is about as far as economic analysis can lead us. Many economists will stop here. There is no rule as to what kind of research an economist stakes out for himself. It should be recognized, however, that the economist who limits himself to economic analysis is not yet in a position to give advice on economic policy. Other factors have to be considered before policy conclusions can be drawn.

### Institutional Economics and Economic Engineering

Recovery measures must be appraised in terms of their administrative feasibility. An economist who recommends an increase in expenditures must know which expenditure programs have been so prepared that they can be increased within a given period of time without resort to makeshift work. If economists are to blame for the slow progress in getting recovery measures under way, then it is because they have failed to persuade the policy makers to prepare beforehand a work program which could be undertaken at short notice.

The time factor for effectiveness of antirecession measures in relation to the time factor of the prediction is important. It would not be very useful to initiate antirecession measures now if they are likely to become effective only at a time when the economy will be in an upswing again.

Thus, it is necessary to study the time span needed between the initiation of, let us say, a public works program and the actual placement of orders and hiring of workers. This time span is particularly long in some cases, such as when acquisitions of sites or rights of way are implied or when programs require legislative action not only of the Federal Government but also of state and local governments. Where programs have been prepared in advance and have been kept "on the shelf," they can be activated quickly in the event of a recession.

Some economists have recently recommended tax reduction as an antirecession measure in spite of the fact that, on purely analytical grounds, they conclude that a corresponding increase in expenditure programs could have a stronger antirecession effect. They have recognized, however, that taxes could be reduced promptly, while the initiation of programs of beneficial additional public expenditures would take considerable time. Many antirecession proposals have combined such measures of credit policy as can be most readily adopted with some increases in expenditures which are needed anyway and do not require too long a period of preparation, plus some selected tax reductions. Perhaps it would be useful if the economist would point out during periods of favorable economic conditions what preparatory measures should be adopted in order to be ready for prompt action when and if a recession (or for that matter, an inflation) occurs.

The economist who gives advice must take the institutional facts into consideration. Moreover, he must use his knowledge of the institutional facts in making constructive proposals. This constructive approach may well be called economic engineering.

### Economic Politics

No proposal of antirecession policies has realistic value unless there is a chance that it may find political support. An economist once proposed that the simplest antirecession measure would be to drop dollar bills from an airplane over populated areas. This method could be defended on analytical grounds, and it is certainly technically feasible; it would, however, be political insanity. A program must be so formulated that it has a chance of finding political support. This does not mean that only those measures should be proposed which have greatest political appeal. A responsible economist often will have to recommend measures which are not popular. In these cases he has to examine the reasons for the lack of popularity and to propose a presentation of the measures which would be likely to reduce the resistance.

For example, a recovery program may encounter the argument that it creates a budget deficit. This argument may be met by demonstrating that a deficit would also result from letting the recession deteriorate into a depression. Estimates may, for example, be presented which compare the deficits resulting from a prolonged recession with those resulting from a successful antirecession program over a number of years. It may be further pointed out that a deficit which *results* from a recession or depression yields no assets on the other side of the ledger, whereas a deficit arising from the adoption of an antirecession program creates tangible assets (such as roads and hospitals) and intangible ones (reduction of unemployment and of its attendant hardships and frustrations).

The economist's function in the process of winning political support for an economic program should not be confused with the role of a politician who uses economic arguments to support a politically advantageous situation. I am talking about the economist who must take political considerations into account in constructing and presenting an antirecession program which would have a chance of winning the needed political support.

### Economic Statesmanship

The Employment Act of 1946 wisely prescribed that the Government should use all "practical means . . . to promote maximum employment, production, and purchasing power" consistent with its "needs and obligations and other essential considerations of national policy." The economist who gives advice on economic policy must see the objective—in this case, that of restoring a high and

rising level of economic activity—in the perspective of other objectives of national policy. Assume, for example, that the international situation should necessitate a drastic increase in defense expenditures, such as has been recommended in a number of experts' reports. If, within a short time, the Government were to be embarking on very large additional defense programs for purposes of national security, the responsible adviser would not now recommend special antirecession measures, either public works expenditures or tax reduction. For this reason I hesitated to recommend tax reduction at an earlier time until it became clear what action, if any, the Government would take with respect to national security programs along the lines of the so-called Gaither and Rockefeller reports. Such an appraisal of policies for recovery in the perspective of policies for other national objectives is a function of statesmanship, and the economist, as an adviser, has to make it clear to what extent policies for various national objectives may either support one another or conflict with one another.

Another decisively important aspect of economic statesmanship results from the fact tha policies must be decided under conditions of uncertainty. We all know by sad experience that our economic predictions are, to say the least, imperfect.

Using again the current antirecession policy debate as an example, we find two main attitudes. One of these advocates a continued policy of "wait and see," expecting an early upturn of market forces which would make additional government policies unnecessary. The other view is based on the expectation that the market forces will not bring about an early and adequate recovery and therefore recommends additional recovery measures.

The economist advising the statesman will recognize that, whatever view he personally espouses, he may be wrong. Therefore, he must evaluate the harm done in either case if the policy proves to have been based on an erroneous prediction. Assume that the Government does adopt additional recovery measures but that it turns out that the forces of the market bring about recovery independently. Then the total demand—government plus business plus consumer demand—may become excessive, and demand inflation conditions may develop. This would necessitate the adoption of anti-inflation measures at a later time. In the light of all experience we may anticipate that such anti-inflation measures will not be fully effective, and some price rise may result.

Let us now assume that the Government, advised of the probability of an early upturn in market forces, takes no further action but that, contrary to expectations, the upturn does not materialize. As the labor force grows and capacity to produce rises, unemployment and idle capacity increase.

Both types of error are certainly possible. Therefore, it must be evaluated which error will do the greater harm in the light of all aspects of economic, social, and political (in particular, foreign policy) objectives. This is, in my opinion, the crucial consideration in giving advice on final policy formulation.

A renewed rise in prices at a later time would certainly be undesirable, both from an economic and a social point of view. However, it is my opinion that the failure to counteract effectively the recession would be much more harmful and undesirable. We must consider not only the frustration of the unemployed and the irreparable loss of potential production but also the disruptive effect of the recession on the raw-material-producing foreign countries. The latter effect, in turn, might have serious consequences on foreign policy.

For a decade we have stated with pride that we have established the necessary legislative and administrative machinery and that we have the knowledge for dealing with severe economic fluctuations. Failure to use that machinery and that knowledge to prevent a serious or prolonged recession does great harm to the prestige of our political and economic system in the world and supplies ready-made arguments to the critics of that system. The economic adviser has to consider and present the risks involved in either action or inaction. But, in the last analysis, it is the statesman's responsibility to weigh the respective risks and to make the decision.

# Specificity of Peptides

## New aspects of the specificity of peptides with vitamin and hormone action are described.

D. W. Woolley and R. B. Merrifield

The marked structural specificity required in vitamins and other biologically active substances is a concept so widely held that evidence against such a view excites attention. The purpose of this article (*1*) is to summarize recent work which suggests that several kinds of peptides with recognizable functions in many living things do not conform to the classical picture of rigorous specificity. Rather large changes in chemical structure often do not seriously alter their biological activities. That such a situation should appear among peptides is interesting because the proteins have long been regarded as the prime examples of exquisite structural specificity. This view, too, is undergoing some modification in the light of recent discoveries with certain enzymes and antibodies (*2*).

In the past, the structural specificity exhibited by essential compounds such as the water-soluble vitamins has been striking. Minor variations in chemical constitution, such as the replacement of a $-CH_3$ by $-H$ or $-CH_2 \cdot CH_3$, have led to compounds of much reduced or no potency. Frequently such minor alterations have yielded antimetabolites which antagonize rather than exhibit the biological action. When evidence has been found of lack of specificity, as, for example, in the biotin activity of oleic acid (*3*) or the vitamin $B_{12}$ activity of thy-

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Table 1. Strepogenin activity of various peptides isolated from natural sources. In place of the common abbreviations, the following have been used: A, asparagine; Al, alanine; Ar, arginine; C, half-cystine; G, glutamic acid or glutamine; Gl, glycine or its amide; H, histidine; I, isoleucine; L, leucine; P, proline; Ph, phenylalanine; S, serine; T, tyrosine; V, valine. For discussion of peptides Nos. 1 and 2, see Merrifield and Woolley (*7*); of peptide No. 4, see Tritsch and Woolley (*8*); of peptides Nos. 5 and 6, see Woolley and Merrifield (*10*).

| Peptide | Strepogenin activity (unit/mg) |
|---|---|
| 1. SHLVG | 85 |
| 2. SHLVGAIL | 100 |
| 3. VHGSL | 200 |
| 4. LVCGlGAr | 200 |
| 5. CTIGACPLGl (oxytocin) | 300 |
| 6. CTPhGACPArGl (vasopressin) | 150 |

midine (*4*), no threat to the basic concept has arisen because the oleic acid, thymidine, and so on have been indicated to be products formed in the organism through the action of the vitamin in question. When the product is supplied in sufficient amounts, the machinery needed for its manufacture may no longer be required. However, this "product explanation" appears unable to account for the lack of specificity to be discussed in this article.

Among the hormones there have been a few striking examples of lack of specificity, but these have not been enough to disturb the general conclusion that, for a given hormonal effect, one needs a single substance or a close relative of it. Some notable exceptions have been the estrogenic action of diethylstilbestrol and of genistine (*5*) and the indoleacetic acid activity of 2,4-dichlorophenoxyacetic acid. Now that similar lack of specificity begins to appear for peptides which are vitamins, hormones, or poisons, the shortcomings of the classical view about specificity must be given more consideration.

## Strepogenin Activity of Certain Peptides

A peptide which stimulates the growth of *Lactobacillus casei* and some species of streptococci has been recognized for many years (*6*) and called strepogenin. Recently several pure peptides showing this activity have been isolated and identified (*7–10*). One of these is serylhistidylleucylvalylglutamic acid (SHLVG), isolated from partial hydrolyzates of insulin. A peptide giving rise to these same five amino acids on hydrolysis has very recently been isolated from digests of ribonuclease (*11*) and identified as valylhistidylglutamylserylleucine (VHGSL) by C. H. W. Hirs (*12*).

In the standard strepogenin test with *Lactobacillus casei*, this peptide was 2.3 times as potent as SHLVG. Clearly, then, the amino acid sequence in a pentapeptide containing serine, histidine, leucine, valine, and glutamic acid was not crucial for its growth-factor activity. This sequence could be either SHLVG or VHGSL. Data on the strepogenin potencies of several peptides isolated from natural sources are given in Table 1.

The failure to find a need for a specified sequence of amino acid residues in the peptide chain was not as surprising as was the finding that many of these amino acids could be replaced by others of different chemical structure. The high potency of oxytocin, vasopressin, and leucylvalylcysteinylglycylglutamylarginine would not be anticipated from the fact that SHLVG was active.

A commonly held concept is that peptidic growth factors are active merely because they supply a particular amino acid in an available form. This idea is not adequate to explain all of the strepogenin data. Study of a considerable number of additional peptides has shown that no single peptide-bound amino acid is required for activity. Perhaps there are interchangeable amino acids either of which will confer activity if present in a suitable peptide. Thus, because all known active strepogenins contain either a serine or cysteine residue, one might conclude that what is needed is either a serine- or cysteine-containing peptide and that these are interconvertible by the organism. Nevertheless, several serine or cysteine peptides (for example, seryltriglycylglutamic acid and cysteinylhistidylleucylvalylglutamic acid) were either inactive or of low potency. More is needed than the mere presence of serine or cysteine. What stands out most clearly is that a variety of peptides show high strepogenin activity and that the structural resemblance of those which do is rather remote. Neither the sequence of amino acid residues nor the exact nature of these residues seems to be crucial for this biological activity.

It must not be forgotten, however, that some rather slight structural changes convert an active peptide into a specific antagonist of the growth factor. Thus, threonylhistidylleucylvalylglutamic acid (*13*) is such an antistrepogenin even though it differs by only one $—CH_3$ from the active SHLVG.

We might console ourselves, as some have done, by saying that strepogenin is a special case with no general biological significance. We might, for example, point out that this factor is not absolutely essential for the growth of the organism. *Lactobacillus casei* will eventually grow maximally in the basal medium if incubation is continued long enough. It is therefore of interest to find other cases of this lack of specificity among other biologically active peptides.

## Peptides with Toxic Action

Consider first the case of lycomarasmin. This modified tripeptide of asparagine, glycine, and α-hydroxyalanine is a toxin, formed by the fungus *Fusarium lycopersici*, which causes excised tomato leaves to wilt and curl. A number of closely related peptides were examined for such toxic action in 1948 (*14*), and it was found that the situation was somewhat similar to that now observed with strepogenin. Neither the sequence nor the mode of linkage nor even the exact nature of the amino acid residues was crucial, even though just any peptide would not exhibit the activity. In fact, some were antagonistic.

An analogous situation with respect to the antibiotic peptide gramicidin S was described recently by Katchalski *et al.* (*15*). Random polymerization of the five amino acids found in the natural antibiotic led to antibiotically active peptides. Presumably, several isomeric peptides each contributed antibacterial activity.

We might dismiss these two examples as being concerned with peptides which are poisonous, and consequently of only limited interest for real biological activity. There is much merit in such an objection.

## Oxytocic Activity

The same phenomena, however, begin to appear for the hormone oxytocin. The natural hormone isolated from the hypophysis has the structure indicated in Table 1 (*16*). It was not too surprising to learn that another hormone of the hypophysis—namely, vasopressin—exhibited some oxytocic activity (*16*)

because the two hormones differed only in that, in vasopressin, the isoleucine of oxytocin was replaced by phenylalanine and leucine was replaced by arginine or lysine (*9*). Similarly, the potency of a synthetic peptide which was the same as oxytocin except for the fact that isoleucine was replaced by valine (*17*) fitted well with the classical concept of structural specificity. These findings show that the nature of every amino acid residue in the oxytocin molecule is not crucial for activity. Some can be exchanged for related residues. However, the recent demonstration by Schwarz, Bumpus, and Page (*18*) and by Dekanski (*19*) that angiotonin (hypertensin) has high oxytocic activity (when tested on isolated rat uterus) recalls once again the findings with strepogenin and lycomarasmin and gramicidin S. Angiotonin has the structure aspartylarginylvalyltyrosylisoleucylhistidylprolylphenylalanine (*18*) and thus bears little resemblance structurally to oxytocin. If we may extrapolate from the experience with strepogenin, we might not be surprised to find that a peptide composed of the eight amino acids in natural oxytocin, but with their sequence completely changed, would show oxytocic activity (compare SHLVG with VHGSL in the strepogenin test).

Another case of the lack of structural specificity of a peptidic hormone is the vasopressin activity of pepsitensin. Although the structure of pepsitensin has not been established yet, the evidence (*20*) strongly suggests that it will differ considerably from that of vasopressin.

Because the assay systems for biologically active peptides are complex, there is a possibility that simplification of the systems to single chemical reactions might sharpen the specificity. There is, however, no assurance that this will be the case. Some expansion of the classical view about specificity seems to be required.

## Summary

The data now at hand show that specificity among biologically active peptides is probably not as exquisite as might have been deduced from experiences with some of the water-soluble vitamins. It is plain that a given biological effect can be evoked by peptides which differ considerably. It is likewise plain that the effect cannot be evoked by a number of other peptides. There is apparently some specificity, but more is involved than that incorporated in the classical view.

### References and Notes

1. This study was supported in part by a grant from the U.S. Public Health Service.
2. K. Bailey, *Nature* 180, 833 (1957).
3. V. R. Williams and E. A. Fieger, *J. Biol. Chem.* 166, 335 (1946).
4. W. Shive, J. M. Ravel, R. E. Eakin, *J. Am. Chem. Soc.* 70, 2614 (1948).
5. R. B. Bradbury and D. E. White, *J. Chem. Soc.* 1951, 3447 (1951).
6. H. Sprince and D. W. Woolley, *J. Am. Chem. Soc.* 67, 1734 (1945).
7. R. B. Merrifield and D. W. Woolley, *J. Am. Chem. Soc.* 78, 358 (1956).
8. G. L. Tritsch and D. W. Woolley, *J. Am. Chem. Soc.* 80, 1490 (1958).
9. E. A. Popenoe, H. C. Lawler, V. du Vigneaud, *J. Am. Chem. Soc.* 74, 3713 (1952).
10. D. W. Woolley and R. B. Merrifield, *J. Am. Chem. Soc.* 76, 316 (1954).
11. C. H. W. Hirs, W. H. Stein, S. Moore, *J. Biol. Chem.* 221, 151 (1956).
12. Dr. Hirs generously gave us the VHGSL used in this study.
13. R. B. Merrifield, *J. Biol. Chem.* 232, 43 (1958).
14. D. W. Woolley, *J. Biol. Chem.* 176, 1299 (1948).
15. E. Katchalski, A. Berger, L. Bichowsky-Slomnitzki, J. Kurtz, *Nature* 176, 118 (1955).
16. V. du Vigneaud, *Harvey Lectures Ser. 50 (1954–55)* (1956), p. 1.
17. R. A. Boissonnas, S. Guttmann, P. A. Jaquenoud, J. P. Waller, H. Konzett, B. Berde, *Nature* 178, 260 (1956).
18. H. Schwarz, F. M. Bumpus, I. H. Page, *J. Am. Chem. Soc.* 79, 5697 (1957).
19. J. Dekanski, *Brit. J. Pharmacol.* 9, 187 (1954).
20. H. Tuppy, *Arch. exptl. Pathol. Pharmakol. Naunyn-Schmiedeberg's* 228, 94 (1956).

# News of Science

## Hughes Appointed to Editorial Board

On 1 August Donald J. Hughes, senior physicist at the Brookhaven National Laboratory, was appointed to the Editorial Board of *Science*. Hughes, who was born in Chicago in 1915, took both his undergraduate and graduate work at the University of Chicago. His research for the Ph.D., which he obtained in 1940, was in the field of cosmic rays, in connection with which he was a member of a cosmic ray expedition to South America in 1941. He remained at Chicago as an instructor in the physics department until the U.S. Navy called him to direct a section on underwater ordnance research at the Naval Ordnance Laboratory in Washington, D.C., in 1942. Until 1943, Hughes remained at the Naval Ordnance Laboratory working with mine and torpedo detectors, including a period spent with the British ordnance at Edinburgh, Scotland.

Early in 1943, Hughes joined the Manhattan Project at the University of Chicago at the time the first pile was starting operation. He did classified pile neutron research, including 1 year (1944) spent at Hanford, Washington, when the large chain-reacting piles for production of plutonium were put in operation. In 1945 he returned to Chicago and became director of the Nuclear Physics Division of the postwar Argonne National Laboratory, which was formed by the Atomic Energy Commission. He left Argonne in 1949 to become a senior physicist in charge of a group doing pile neutron research at Brookhaven National Laboratory. In addition, Hughes served as chairman of the Nuclear Cross Sections Advisory Group of the Atomic Energy Commission.

Hughes has worked in practically every branch of neutron physics that can be handled at the pile. With Spatz and Goldstein, at Argonne, he developed a method for measuring fast neutron cross sections, which became the basis of G. Gamow's theory of the origin of the elements and was also applied to the design of fast neutron breeder reactors, such as the experimental breeder reactor now in operation at Arco, Idaho. At Brookhaven, Hughes' group has done significant work in connection with neutron "mirrors," in which the mirror reflection of neutrons was used to measure the neutron-electron interaction, which has a bearing on modern meson theory. His group has also developed the "fast chopper," which has yielded much nuclear information, and techniques of working

with "cold" neutrons used to study the motions of atoms in crystals.

Hughes has written several books: *Pile Neutron Research* (Addison-Wesley, Cambridge, Mass., 1953), *Neutron Optics* (Interscience, New York, 1954), *Neutron Cross Sections* (Pergamon, New York, 1957), and *On Nuclear Energy* (Harvard University Press, Cambridge, Mass., 1957). In addition, he has written many articles for various technical and nontechnical journals and periodicals. He spent the 1953–54 academic year as a Fulbright professor in Europe, served as chairman of the Federation of American Scientists, and prepared the compilation *Neutron Cross Sections,* which was distributed at the Geneva Atoms for Peace Conference in August 1955. *Pile Neutron Research, Neutron Optics,* and *Neutron Cross Sections* have all been translated by the U.S.S.R. into Russian. At present he is managing editor for a series of books entitled *Progress in Nuclear Energy,* published by Pergamon Press, London. Several trips to Europe have afforded him an opportunity to keep in touch personally with atomic energy research in many countries on both sides of the Iron Curtain, the latest visit having been a trip to Poland and the U.S.S.R. at the invitation of the respective Academies of Science of these countries.

Hughes will be in Geneva, Switzerland, late this summer as one of the U.S. representatives to the Second International Conference on Peaceful Uses of Atomic Energy. He has been requested by the secretary-general of the conference to present a paper reviewing the most recent world-wide nuclear data of technical importance. In connection with the conference, a second, completely revised edition of *Neutron Cross Sections* has recently been completed at Brookhaven National Laboratory under Hughes' supervision. It is now being published by the U.S. Government Printing Office for distribution at the Geneva meeting and for general sale.

The Physical Science Study Committee, recognizing the scarcity of interesting literature of science at the high school level, has launched a new program, under a grant from the National Science Foundation to the Massachusetts Institute of Technology, to revise the teaching of physical sciences in the high schools. As a supplement to this program, Hughes has recently completed a monograph for the committee, entitled *The Story of the Neutron.*

In addition to being an authority on nuclear physics, Hughes has also written on the relationship of science to society for newspapers and magazines, and has recently completed a chapter "Atoms, energy and peace" for Lyman Bryson's

forthcoming book, *An Outline of Man's Knowledge.*

Hughes' wide experience in research and in publishing make him particularly well qualified for membership on the Editorial Board. The editorial staff takes pleasure in announcing his appointment and in welcoming him to the board.

## Relocation of the 1959 and 1961 Annual Meetings of the AAAS

When Denver was chosen as the site of the December 1959 annual meeting of the AAAS, it was expected that new, large hotel and exhibit facilities, now under construction, would go into operation by September 1959. It is now unlikely that the contract date will be met. The other facilities of Denver, though some have been increased, are inadequate for a large-scale meeting that would also be compact and convenient. Accordingly, the AAAS Board of Directors authorized a postponement of the Denver meeting until 1961 and other arrangements for next year. The Executive Committee has just approved the following schedule: December 1959, Chicago (instead of Denver); December 1960, Philadelphia (no change); December 1961, Denver (instead of Milwaukee); December 1962, Boston (no change); December 1963, Milwaukee.

It is regretted that these changes are necessary. Some of the societies have already appointed representatives on the AAAS Council from the Denver area and many have already given thought to local program chairmen for 1959. It is hoped, however, that this announcement arrives in time to avert any serious inconvenience.

The association has not met in Chicago since 1947 and next year's meeting there—in large hotels in the "Loop," such as the remodeled Morrison and the Sherman, will be of maximum convenience. The first winter meeting of the AAAS in Denver in 1961 will profit by the 2-year delay.

RAYMOND L. TAYLOR
*AAAS*

## Science Education for Negroes

The National Urban League, New York, a voluntary interracial agency, has announced plans for a nationwide educational program designed to direct a larger number of Negro students into careers in scientific and technical fields. The program, entitled Tomorrow's Scientists and Technicians, will be conducted by local Urban Leagues throughout the nation "to search for and discover youth who have high potential ability for careers as professional workers and technicians, and to provide them with adult encouragement, guidance and assistance to help them reach their potential." While the program is designed especially for Negro youths, it will not be restricted to them.

A National Technical Advisory Committee of scientists and technicians drawn from business, industry, labor, and education will serve as program consultants. This group will be headed by J. Ernest Wilkins, Jr., assistant manager of research and development for the Nuclear Development Corporation of America at White Plains, N.Y. Also, a national sponsoring committee representing varied civic interests is supporting the 10-year effort, which is expected to cost at least $100,000 a year.

The program will acquaint adult leadership groups in hundreds of communities with ways to help motivate students to raise their career aspirations. The program will include group guidance sessions for parents and youth; face-to-face meetings with persons of achievement; visits to colleges to learn about admission requirements; scholarships; occupational trips to offices and industrial plants; visits to science exhibits and fairs; and part-time and summer jobs.

Although the present occupational position of the Negro in America is better than it has ever been, many gains remain to be made. Negroes are very poorly represented among the nation's scientists and in the professions generally. Of the 28,000 engineers who were graduated from the nation's schools last year, fewer than 200 were Negroes. The situation is similar for other professional fields.

Thousands of able Negro youths do not get encouragement, either at home or in school, to work toward high scholastic goals. With no motivation, and with fear that years devoted to difficult studies would lead only to frustration, these

young people lose ambition. Many leave high school before graduation. Others remain to graduate but find occupations far below their potential. Only 5 percent of all Negro high-school graduates enter college, as against 25 percent of white graduates.

## AAAS Theobald Smith Award

The Theobald Smith Award of $1000 and a bronze medal, which has been given yearly since 1937 (except for a lapse during the war years) by Eli Lilly and Company of Indianapolis, Ind., under the auspices of the AAAS, will be presented at the association's 125th meeting in Washington, 26–31 Dec. Nominations are now being requested for the award. They may be made by fellows of the AAAS and should be sent to the secretary of the Section on Medical Sciences, Dr. Allan D. Bass, Department of Pharmacology, Vanderbilt University School of Medicine, Nashville 5, Tenn.

The prize is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." Any investigator is eligible who was less than 35 years of age on 1 Jan. 1958 and who is a citizen of the United States. The research is not to be judged in comparison with the work of more mature and experienced investigators.

Nominations must be received *before 1 Sept.* The secretary requests that six copies of all data be submitted. The nomination should include a curriculum vitae, a statement summarizing the nominee's scientific contributions with an evaluation of their significance, and reprints of his or her more important publications.

The committee of judges consists of Alfred Gellhorn, Institute of Cancer Research, Columbia University College of Physicians and Surgeons, New York; Horace W. Magoun, University of California Medical School, Los Angeles; Joseph L. Melnick, Baylor University College of Medicine, Houston, Texas; and Albert B. Sabin, Children's Hospital Research Foundation, Cincinnati, Ohio. Gordon K. Moe, New York Medical Center at Syracuse, chairman of Section N–Medical Sciences, is chairman, *ex officio*; Dr. Bass will serve as *ex officio* secretary.

## New Electromagnet

A continuously operating electromagnet of approximately 100,000 gauss has been constructed and put into operation at the Berkeley campus of the University of California. The new machine, which was built at the university's new low-temperature laboratory, has the features of ultra-high strength, continuous operation, homogenous field, and a volume of field of about 30 cubic inches. These characteristics make the instrument suitable for precise measurement of the effect of a magnetic field on the properties of materials.

Extremely low temperature-readings are expected during the course of experiments conducted with the magnet. William F. Giauque, Nobel laureate and head of the laboratory, expects to reach temperatures below those reached in past work. In the 1930's Giauque attained a reading of −459.55°F.

The magnet is a solenoid 26 inches long and 15 inches in diameter, with a center hole 4 inches in diameter. Despite its small size, in comparison with the magnets used in cyclotrons, the new device produces a much larger magnetic field than cyclotron magnets.

Using 10,000 horsepower of electrical energy, which is converted into heat in the course of maintaining the field, the magnet requires large-scale auxiliary equipment for cooling. Approximately 300 cubic feet of kerosene are pumped each minute through annular spaces between layers of the conductor in the solenoid and then are passed through pipes over which water flows. The magnet is operated in an atmosphere of carbon dioxide and nitrogen.

The magnet will be used for study in a variety of fields, among which are: entropy measurements, solid-state physics, nuclear alignment of radioelements, temperature scale and thermometry, heat capacity, magnetic measurements, thermodynamic relationships of magnetic data, and spectroscopic observations at low temperatures.

## IGY Notes

A suggestion for a 6- to 12-month extension of the International Geophysical Year was made by the vice president of the U.S.S.R. IGY Committee in a recent issue of the Soviet magazine *New Times*. Citing the late starts of many IGY participants, the atypicality of meteorological phenomena since the opening of the study period on 1 July 1957, and the waste inherent in abandoning uncompleted antarctic programs, Y. Boulanger concluded his statement by saying: "We Soviet scientists are confident that the extension of the IGY and the antarctic program and broader international cooperation in these fields would be of inestimable value to science."

* * *

Data from the antarctic phase of the United States' IGY effort will be processed at two midwestern universities. Ohio State University will analyze glaciological information gathered at six IGY stations, and the University of Wisconsin will handle material from the fields of seismology and gravity. The two data-reduction centers, designated and supported by the National Science Foundation, will be staffed largely by personnel recently returned from Antarctica where they collected the data that will now be subjected to analysis.

* * *

Another IGY project, the Dolphin Expedition, carried out by the Scripps Institution of Oceanography and the U.S. Fish and Wildlife Service, has mapped a new subsurface current of gigantic dimensions in the area of the intersection of longitude 140° W with the Equator. Flowing east along the Equator to the Gallapagos Islands, the "river" is calculated to be 3500 miles long, 250 miles wide, and 1000 feet deep, and to lie only 100 feet below the westward-flowing surface South Equatorial Current. Held to be comparable in importance with the discovery of the jet stream in the atmosphere, the new current, it is hoped, will be named in honor of Townsend Cromwell, who discovered it in 1952 while working for the Fish and Wildlife Service.

## Soviet Education

Edward H. Litchfield, chairman of a group of American educators which has just completed a survey of higher education in the Soviet Union, recently issued a preliminary report on the findings of the group.

Two aspects of the report stand out, particularly when a comparison is made with American educational patterns: first, the general attitude of Soviet society toward higher education, and, second, the physical plant of the educational system.

There is, among policy makers and students in the Soviet Union, "an almost universal belief in the value of higher education." "Students . . . regard higher education as of tremendous importance. Two to three times as many apply as are accepted. Many now and 80 percent in a few years will be required to work in industry for two years before entering the university. Those who are finally admitted are expected to work from nine to ten hours each day six days a week plus home study on Sunday in many cases. In addition, they are expected to participate actively in scientific societies and sports clubs. . . .

"Industry releases its employes at full pay for more than 250 million man hours each year in order to permit the workers to do work in universities or in

engineering and other university-level institutions. At a time of some shortage of industrial workers, more than 800,000 are each permitted two full months of study with all expenses paid."

"The superior student is regarded as a 'hero,' not as a 'grind.'

"The government shows its deep commitment to higher education in many ways. Scholarships are large in amount and given to from 80 percent to 90 percent of the students so that virtually all of the superior men and women are able to attend. Salaries and perquisites for teaching and research personnel are among the highest in the nation with the consequence that scholarship attracts a very high percentage of the country's most able people."

Supporting the desire on the part of students for higher education is the government's willingness to pay the very high costs that are involved in money, in plant, and in human effort.

"The Minister of Education claims total plant development in the next five years for a resident student population of constant size will exceed one and one-half billion dollars."

"The state's investment in capital plant and equipment has been large and apparently will continue to be. At the most cautious appraisal of the ruble, at least $200 million have been invested in during the last nine years and construction is still under way."

"Further evidence of the seriousness of Soviet commitment is found in the size and extensiveness of library collections. While a definitive appraisal ought to be undertaken by specialists, it would nevertheless appear that, judged by the most conservative standards and making ample allowance for variations in terminology, the Moscow University library collection is one of the largest in the world. Its new capacity of 12.5 million volumes may well be the largest.

"The University of Leningrad claims 4.5 million volumes, and the large polytechnical institute in the same city is said to receive over 600 foreign periodicals. A relatively small university in Georgia with 4300 full-time students boasts of more than 1.5 million volumes. The University of Middle Asia in Tashkent, established after the Revolution, has but 4000 full-time and 1000 correspondence students, but already has accumulated better than a million volumes."

The report ends its evaluation of the positive side of Soviet higher education with this statement:

"The Soviet Government and its people have dedicated themselves to higher education to a degree which must inspire their allies and give very serious pause to any nation which finds itself in a competitive position."

## Grants, Fellowships, and Awards

*Cardiovascular research.* Applications by research investigators for support of studies to be developed during the fiscal year beginning 1 July 1959 are now being accepted by the American Heart Association. The deadline for research fellowship applications and established investigatorships is *15 September 1958*, for grants-in-aid *1 November 1958*. Applications may be made in the following categories:

Awards for established investigatorships are made for periods of up to 5 years, ranging from $6500 to $8500 yearly for independent investigators.

Advanced research fellowships are awarded for 1 or 2 years to postdoctoral applicants who are not qualified to conduct independent research. The stipends range from $4600 to $6500 annually.

Grants-in-aid are made to experienced investigators to help underwrite the costs of specified projects, such as expenses for equipment, technical assistance, and supplies.

Further information and application forms may be obtained from the Assistant Medical Director for Research, American Heart Association, 44 E. 23 St., New York 10, N.Y.

*General.* Applications for the regular postdoctoral fellowships of the National Science Foundation will be accepted *through 2 September*. Fellowships will be awarded in the mathematical, physical, medical, biological, engineering, and other science fields, including anthropology, psychology (other than clinical), geography, certain interdisciplinary fields, and selected social science fields. Candidates must be citizens of the United States with special aptitude for advanced training and must hold the doctoral degree or have the equivalent in training or experience. The stipend is $3800 per year. A limited travel allowance, as well as tuition and fees will be paid. For further information and applications write to the National Academy of Sciences–National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C.

## News Briefs

The Army has had its third success in recovering the nose cones of Jupiter missiles fired from Cape Canaveral Air Force test center. With the latest recovery of a full-sized cone, 17 July, the Army announced that a "satisfactory solution" had been found to the re-entry problem of such missiles. With the aid of a marker balloon, a small light, dye markers, and a radio transmitter, the cone was quickly found by Navy ships in the area and recovered by frogmen.

Nose cones, which shield a warhead from the heat built up by impact with the earth's atmosphere, have been designed along two general lines, the "heat sink" and "ablation" approaches. The sink type concentrates and contains the heat in a thick copper shield while at the same time slowing the speed of descent by the utilization of shock waves. The ablation system, which is believed to be the one employed in the most recently recovered cone, depends on the gradual peeling or burning off of a number of layers of thin, nonmetallic substances on the outside of the cone.

* * *

A trust fund to honor the late Gordon F. Ferris is being established at Stanford University. The purpose of the fund will be to promote interest and research in entomology by extending financial support to promising young students. Contributions may be made payable to the Gordon F. Ferris Memorial Fund and sent to: The General Secretary's Office, c/o Richard F. O'Brien, Stanford University, Stanford, Calif.

* * *

The population of the world may rise to 4000 million or more by 1980 and to 6000 or 7000 million by the end of the century, according to a new United Nations study on future population trends. The mid-century world population is estimated at 2500 million. The report, entitled *The Future Growth of World Population*, was prepared by the Population Branch of the United Nations Bureau of Social Affairs.

## Scientists in the News

SELMAN A. WAKSMAN will retire next month as director of the Rutgers University Institute of Microbiology, the organization at which he did his Nobel Prize winning work with antibiotics. He will be succeeded in that post by J. OLIVER LAMPEN, who is currently director of the division of biochemical research at the Squibb Institute for Medical Research.

Waksman, who was born in Russia, came to the United States in 1910 and entered Rutgers as an undergraduate a year later. He took his B.S. and M.S. there and his Ph.D. at the University of California. In 1918 he joined the faculty of Rutgers and has been a member of it in various capacities ever since.

The work which resulted in the discovery of streptomycin in 1943, the basis for the Nobel award, had its roots in the soil microbiology studies which Waksman began while he was a Rutgers undergraduate some 30 years before.

JAMES L. KASSNER, professor of chemistry at the University of Alabama School of Chemistry since 1929, has been appointed to the new Robert Ramsay

chair of chemistry. The new chair was made possible by a gift to the University of Alabama from the late Erskine Ramsay, industrialist and philanthropist of Birmingham.

H. F. ROBINSON has been appointed head of the newly organized department of genetics at North Carolina State College.

This year's honorary degree recipients include the following:

LYLE T. ALEXANDER, chief, Soil Survey Laboratories, U.S. Department of Agriculture, from the University of Arkansas.

RICHMOND K. ANDERSON, associate director for biological sciences at the Rockefeller Foundation, from Harvard University.

EDGAR H. DIX, JR., assistant director of research, Aluminum Company of America, from Carnegie Institute of Technology, Pittsburgh.

PAUL B. SEARS, chairman of the Conservation Program at Yale University, from Oberlin College.

HARRY C. TRIMBLE, special consultant to the dean of Harvard Medical School, from Harvard University.

JOHN H. VAN VLECK, professor of mathematics at Harvard University, from Oxford University .

THORNTON PAGE, formerly on the staff of the Operations Research Office, Johns Hopkins University, has been appointed professor of astronomy at Wesleyan University, Middletown, Connecticut.

GEORGE D. BEAL will retire as a director of research at Mellon Institute on 31 August, after 32 years of service.

Beal has had a career in chemical research, pharmaceutical investigation and education, and research management in a number of industrial fields, including textiles, paper, leather, waxes, varnishes, and food chemistry. His nearly 100 publications deal with basic chemistry, agriculture, food preservatives, industrial hygiene, glass containers, scientific standards, and the philosophy of research.

RICHARD COURANT, director, Institute of Mathematical Sciences, New York University, has been presented the Navy Distinguished Public Service Award. The award, highest the Navy confers on civilians, was given to Courant for his contribution to the Department of the Navy in the field of mathematical sciences.

RICHARD J. DELONG has been appointed virologist at the Toledo Hospital Institute of Medical Research. He will investigate the relationship of virus to neoplasia.

EDWARD M. PURCELL, Nobel laureate in physics, will be the first Donner Professor of Science at Harvard University.

President Nathan M. Pusey announced appointment of the 45-year-old investigator in nuclear magnetism as the first scientist to hold the new professorship, one of five established this spring at major centers of learning by the Donner Foundation of Philadelphia. An endowment of $500,000 will be established for each professorship.

In making the grant, the Donner Foundation called scientific education "of utmost importance" in the present age. The new chairs are provided for the field of the physical sciences.

RANDAL M. ROBERTSON, director of the Physical Sciences Division, Office of Naval Research, has joined the staff of the National Science Foundation as assistant director for mathematical, physical, and engineering sciences.

DAVID S. GRICE, assistant clinical professor of orthopedic surgery at Harvard University, has been appointed chairman of the department of orthopedic surgery at the University of Pennsylvania School of Medicine, effective 1 September. He will succeed PAUL C. COLONNA, who will retire 1 September following 16 years as chairman of the department. Colonna will continue his practice in Philadelphia.

EARL A. ALLUISI, former staff member at the U.S. Army Medical Research Laboratory, has joined the staff of the Missile Systems Division, Lockheed Aircraft Corporation, Sunnyvale, California.

DONALD C. GREAVES, associate professor of psychiatry at the University of Oklahoma School of Medicine, has been named chairman of the department of psychiatry of Kansas University Medical Center, Kansas City.

BRIAN MACMAHON, currently of the College of Medicine of the State University of New York in Brooklyn, has been named professor and head of the department of epidemiology at the Harvard School of Public Health. He succeeds JOHN E. GORDON, who retired on 1 July to become professor emeritus of preventive medicine and epidemiology.

The Psychological Corporation has announced that ALBERT K. KURTZ, professor of psychology at the University of Florida, has taken a one-year leave of absence to direct a project on the training of radio code operators under a contract with the Office of Naval Research.

JOHN B. YOUMANS, dean of the Vanderbilt University School of Medicine, has resigned, effective 30 August, to become head of army medical research.

SAM L. CLARK, professor of anatomy and head of the department at Vanderbilt, has been named acting dean.

GEORGE ST. J. PERROTT, chief of the Division of Public Health Methods, U.S. Public Health Service, retired on 30 June. He has been succeeded by WILLIAM H. STEWART of the staff of the surgeon general.

VYTAUTAS J. BIELIAUSKAS, formerly with the Richmond Professional Institute of the College of William and Mary, has joined the faculty of Xavier University, Cincinnati, Ohio, as associate professor of psychology.

WILLIAM R. TAYLOR, professor of botany at the University of Michigan, has been elected a foreign corresponding member of the Institut de France, Academie des Sciences.

## Recent Deaths

EDWIN G. BURROWS, Storrs, Conn.; 66; professor of anthropology at the University of Connecticut until his retirement in 1957; specialist on South Pacific peoples and their customs; 13 July.

CHARLES E. FRILEY, Ames, Iowa; 70; president of Iowa State College from 1936 until his retirement in 1953 and dean of the college's Science Division from 1932 to 1935; member of the staff of the Agricultural and Mechanical College of Texas for 20 years before he came to Iowa; 11 July.

CATHERINE R. KELLEY, Nashua, N.H.; 82; founder and staff member of Doctors Hospital in New York; was in charge of the newly established heart laboratory of Bellevue Hospital in 1912; operated one of the first electro-cardiographs in existence; 14 July.

ISIDOR C. RUBIN, London, England; 75; former clinical professor of gynecology at the College of Physicians and Surgeons, Columbia University; the College of Medicine, New York University; and New York Medical College, Flower and Fifth Avenue Hospitals; chief gynecologist of Mount Sinai Hospital from 1937 to 1945; specialist on the problems of childbirth and childless marriages; known for his test for sterility in women; 10 July.

*Erratum*: In the report by H. Vasken Aposhian on "Protection by D-penicillamine against the lethal effects of mercuric chloride" [*Science* 128, 93 (11 July 1958)], the heading of the last column of Table 1 should have been "Percent," and not "Survival (%)." Mortality, and not survival, is given in this column.

# Book Reviews

**Inspection for Disarmament.** Seymour Melman, Ed. Columbia University Press, New York, 1958. 291 pp. $6.

Abraham Lincoln, voicing his conviction that bold ideas and new proposals must come from without the Government, once wrote that "the people will save their Government if the Government itself will do its part only indifferently well." A group of "outsiders" working under the aegis of Columbia University's Institute of War and Peace Studies has succeeded in a combined effort which would have pleased Lincoln mightily; they have come to grips with one of the thorniest and yet most compelling problems of the nuclear era—the task of inspecting for weapons should the nations of the world agree to disarm.

Writing in the foreword, William T. R. Fox states the problem and the hope in a single sentence: "New vistas for negotiation and agreement would be opened up by a technically well-founded judgment that it would be possible to install on this planet a disaster-proof alarm system to detect and identify a clandestine violator of a disarmament agreement." He makes it clear that the technique of arms control must be capable of ferreting out "militarily decisive amounts" of forbidden war materials. The double emphasis—militarily decisive and disaster-proof—strikes a note of realism that has been lacking in the language of the prophets of doom who insist on fool-proof or cheat-proof inspection.

The book, as organized by Seymour Melman, a dynamic industrial managerial expert at Columbia University, consists of three parts. There is a general report of some 50 pages which defines the problems of inspection and surveys the gist of the 18 individual reports which follow. Then there follow three brief reports of "evasion teams" which were assigned the task of finding loopholes in the inspection systems for disarmament.

I would suggest that the reader savor the full flavor of the 18 separate reports before tackling the general report. Some of the specific reports are so compressed that editor Melman faced an extremely difficult summarizing chore. That Melman succeeded in keeping his 18 authors from wandering away from the main topic is a notable achievement.

One of the most refreshing aspects of the book is that most of the contributors are newcomers to the disarmament field. This probably accounts for the attitude of enthusiasm and optimism which they adopt.

The Columbia group began its work early in 1957 with financial support from the Institute for International Order. They energized themselves with the incentive that a disarmament agreement "would help to preserve the human species and to prevent a world holocaust." However, they divorced themselves from the politics of such an agreement and fixed their attention upon a workable inspection system.

The over-all approach to this challenging problem is a bold one. There is a direct address to the central issue of general disarmament on a broad scale rather than to piece-by-piece, incremental arms limitation; this may be viewed by some as unrealistic, but the value of the study is that it is not watered down. Indeed, there are many today who feel both that the past decade of arms talks have failed because they have aimed too low and that a more radical approach might work.

Not all of the 18 expert opinions on inspection can be invoked in a brief review. However, one may summarize and consolidate their views. Aerial inspection is appraised as being useful for present-day delivery systems but "of almost no value once the intercontinental ballistic missile becomes part of the military arsenal." Not much hope is held for fiscal inspection since governments are experienced in concealing the use of funds from the public; a small percentage of a national budget can be kept from public scrutiny. In the United States a budget which is a significant fraction of $1 billion is concealed for intelligence purposes.

Jay Orear's analysis of the feasibility of detecting nuclear tests has already been published in the *Bulletin of the Atomic Scientists* and has been given in amplified form as testimony before the Humphrey committee investigating disarmament. If the Columbia study produced nothing more than the Orear paper it would have been well worth the effort, for this analysis demonstrated again that nonaccess to secret data is no real barrier to evaluation of nuclear issues.

Official secrecy serves to inhibit public discussion and undermines confidence in nonofficial studies. Moreover, secrecy can prevent outside experts from putting the right numbers into their analyses. For example, James H. Boyd (Columbia) assumes that the critical mass of fissionable material is about 90 pounds. But such miscues should not detract from the fundamental good aim and focus of the individual studies made by the Columbia group.

It is distinctly encouraging that the report is not monopolized by the atom. The valuable analyses of John B. Walsh (Columbia), Eugene A. Avallone (C.C.N.Y.), Henry Burlage (M.I.T.), and Charles J. Marsel (N.Y.U.) concern missiles, guidance systems, propulsion, and fuels. They emphasize the fact that numbers of nuclear weapons in stockpile are futile digits unless they can be delivered on target. Therefore, delivery vehicles, especially missiles, become of surpassing importance in disarmament-inspection studies.

The multiple approach to inspection, accented throughout the book as highly significant, looks most promising in the case of inspection for missiles. For example, ferreting out the production of an Atlas type ICBM is no needle-in-a-haystack dilemma; this is quite apparent from the fact that the needle is over 100 feet in length. An intercontinental missile is the product of a highly developed and specialized technology. Approximately 40,000 separate parts must be assembled for a single ICBM. Some of these components, such as gyroscopes and accelerometers, require ultraprecision manufacture. For example, only one firm in the United States was able to supply a machine precise enough for ultraprecision gear hobbing.

Very few military men would be willing to stockpile missiles without proof-testing a sufficient initial quantity of the birds to be sure of performance characteristics. Once proof-tested, the missiles would require periodic testing to assure their viability. With this in mind D. G. Brennah (M.I.T.) discusses the detection of high-altitude missile tests in an analysis which should be related to Orear's paper. Clearly, if monitoring posts are installed in the major countries of the world to detect nuclear tests, they ought to be instrumented to detect missiles as well. The spacing between stations is compatible with the twin detection of bombs and missiles.

Vincent Groupé (Rutgers) presents a very brief discussion of the inspection problem as related to biological warfare —or the "poor man's A-bomb." He avoids underlining any conclusion, but

one does not have to read between the lines to realize that, as far as inspection is concerned, the problem of biological warfare is vastly different from all others discussed in the book.

A fascinating insight into the production and smuggling of clandestine arms is provided by Lt. Col. Rivlin, an officer in the army of Israel and a man with 20 years' experience in covert operations. His cloak-and-dagger story is worthy of book-length expansion and might even achieve best-seller lists if he accentuated the humorous angles which developed when the Hagana set out to frustrate British control. The Hagana located a transportation center less than 100 yards from the British Headquarters in Tel Aviv; it smuggled illegal cargo by draping it with an overlayer of fresh fertilizer and in one case with rather ripe onions; over-all, it conducted an efficient underground operation with minimal interference.

Sociologist William M. Evan (Columbia) reports on public opinion polls, including some Gallup polls not published heretofore, on attitudes toward inspection and supranationalism. It is discouraging to find the United States lowest (West Germany and Japan are highest) on the list of countries favoring worldwide inspection. On the other hand, 97 percent of those queried from the membership of the Federation of American Scientists favored inspection (3 percent of the FAS must be given hearing tests!) as opposed to 53 percent of the American Legionnaires favoring inspection for disarmament. (No comment.)

Psychiatrist Alberta Szalita completes the team of 18 experts and provides some highly interesting insights into the psychological aspects of questions bearing on man's capability to live in peace. She asks: "Does man possess psychological equipment for disarmament as well as for evasion?" Commenting on governmental decisions, she states: "It is also plausible to assume that some, if not many, of the decisions are prompted by personal needs and the nature of the personality characteristics of some government representatives." This point is well taken, for when decisions are reached in secret the personality traits of the decision-makers may be decisive.

The reports of the three evasion teams are so terse as to discourage further compression. However, they emphasize that "The sooner a disarmament agreement could be achieved between the nations, the simpler the problem of inspection." They recognize that evasion is easier in a totalitarian country. They stress the fact that the Achilles heel of disarmament is the secreting of stores of arms prior to inspection. They note "how vast a distance still separates the world from genuine full disarmament."

This optimistic yet realistic appraisal of inspection for disarmament does not attempt to deal with political feasibility. Its obvious hope is that disarmament will reduce international tensions and that small steps will lead to big steps. This view will be challenged by those who feel that there can be no mechanical crutch for limping into an era of reduced tension. Arms, they say, are the end products of fear and while more arms increase tension, less arms do not necessarily decrease it in the era of nuclear missiles.

The great merit of this pioneering book is that it penetrates to the core of the disarmament-inspection problem. Columbia University Press manufactured the book in an incredible five weeks in order to bring the book to the public on the heels of the Geneva talks. It is to be hoped that this good timing will give this book the kind of national readership which it so much deserves. It is without doubt the most significant book I have read this year.

RALPH E. LAPP

*Washington, D.C.*

**The Kingdom of Jordan.** Raphael Patai. Princeton University Press, Princeton, N.J., 1958. ix + 315 pp. Illus. $5.

This volume is considerably more important and more widely useful than its simple title would suggest. The real worth of the book is not immediately apparent even in some of the earlier chapters, which, almost in Baedeker fashion, deal with physical environment and supply skeletal outlines of Jordan's history, its contemporary political and economic structure, and its attributes as a Middle Eastern state. Interspersed among these factual recitals, which presumably are intended to serve principally as a context for a detailed treatment of Jordanian society, are enlivening observations on the unifying influence of religion and language, on pan-Arabism, and on the relationship between power-prestige and cultural attitudes. These sociological excursions give advance notice of the fact that the essential contribution of the book, as might be expected from the author's previous writings, consists in a masterly analysis of the human components of Jordan—an analysis that holds good to an almost equal degree for the surrounding Arab countries.

Most of the topics with which the author is mainly concerned—the family, the nomads, villages and towns, religion, health, language, and education—have been discussed by other students of Arab life and Islamic institutions in recent years. Few, however, have shown the depth of perception and understanding of the characteristics peculiar to the several elements in the Jordanian population that are displayed here. Patai is nearly at his best in dealing at some length with the changes that have been taking place in nomadic life since World War I. One misses only an evaluation of two of the more potent of the causative factors: the high-power rifle and the motorcar.

The final chapter, on "Values and outlook," is an excellent synthesis of all that has gone before. It makes clear the problems and perplexities of groups at various cultural levels in a predominantly Muslim environment now in transition between customary and traditional values and the contrasting ones of an ever-encroaching modern world. Caught up in this process, the Arab has to form new concepts of freedom, independence, and leisure. In this connection the author explains some of the manifestations —such as the irruption of street mobs— which of late have seriously complicated political processes in Jordan and neighboring countries. Ascribing many of these phenomena to youths recently emancipated from the discipline of the family, he remarks: "They discover that they can support causes by participating in street demonstrations, that theirs is the freedom of the crowd, the independence gained through anonymity, the emotional satisfaction of mob action. This is a truly new experience. . . . Now . . . they feel free to commit irresponsible acts in the name of patriotic fervor and indignation." Here, the author tacitly suggests, is raw material for Communist endeavor. The question of the hour, he concludes, is: "Into what direction will these changes lead the nascent Jordanian nation?"

HALFORD L. HOSKINS

*Library of Congress*

**The Terpenes.** vol. V, *The Triterpenes and Their Derivatives.* Hydroxy acids, hydroxy lactones, hydroxyaldehydo acids, hydroxyketo acids, and the stereochemistry of the triterpenes. John Simonsen and W. C. J. Ross. Cambridge University Press, New York, 1957. ix + 662 pp. $15.50.

This most recent volume in the monumental series on the chemistry of the terpenes is, for the most part, an extension of volume IV, covering the more highly oxygenated triterpene derivatives. The chemistry of the triterpenoid hydroxy acids, lactones, aldehydo acids, and hydroxyketo acids is presented in the classical framework employed in the earlier volumes of the set.

The use of outline formulas is welcome, but here, as in volume IV, the authors have produced distorted and somewhat confusing diagrams through a

disregard for the symmetry of pentagons and hexagons.

One substantial chapter is devoted to a description of the methods, principles, and arguments employed in the assignment of stereochemical configuration to the triterpenes. This chapter should be of general value to those working with natural products of steroid or terpenoid nature, and to all who aim at complete descriptions of the arrangement of atoms of complex molecules in three dimensions. Extensive use of conformational and optical rotatory analysis is made in arriving at the stereochemistry of the triterpenes, and the chapter in question provides many examples of the use of these powerful techniques.

The volume closes with an addendum to volume III of the series covering sesqui- and diterpenes. The hundred-odd pages so employed provide a welcome summary of recent work, including configurational analysis, with the smaller terpene molecules. In view of his outstanding contributions to the stereochemistry and conformational analysis of terpenes and steroids, it seems particularly appropriate that the elegant series of investigations of D. H. R. Barton and his coworkers on caryophyllene receives full treatment here.

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**Wind and Solar Energy.** Proceedings of the New Delhi Symposium. Arid Zone Research, vol. VII. UNESCO, Paris, 1956. 238 pp. $8.

This attractive volume of some 240 pages combines articles presented at UNESCO's Arid Zone Research program symposium, held in October 1954 at the National Physical Laboratory of India in New Delhi. Wind and solar energy, both gifts of the skies, are regarded as important potential energy sources in the tropical zone, the home of nearly one-half of the world's population.

The list of experts who presented papers included representatives of many nations, East and West being neatly balanced. The subject of wind machines was aptly summarized by the Danish scientist J. Juul and the German U. Hütter. The broad aspects of solar-energy research were envisioned by Farrington Daniels, the sole participant from the United States. The results of extensive Russian work, presented by V. A. Baum, included an array of solar furnaces, water heaters, and an ice machine. French achievements with very high temperature furnaces give promise of industrial success, according to F. Trombe. Speculations on potential applications were visualized by the French and Indian group.

The requirements of the people living in the underdeveloped arid zones were stressed repeatedly. Indian and Russian scientists spoke of potential "important social repercussions, in raising the living standards of much of the world's population and reclaiming the desert." The task is a great and noble challenge to mankind.

The symposium, according to the late André Nizery, "would have abundantly justified itself if its only achievement were that of bringing together scientists working on arid zone problems."

MARIA TELKES
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*New York University*

**A Comprehensive Dictionary of Psychological and Psychoanalytical Terms.** A guide to usage. Horace B. English and Ava C. English. Longmans, Green, New York, 1958. xiv + 594 pp. $10.75.

A good dictionary must be complete in its coverage, accurate in its definitions, and comfortable to use; it is not required to be interesting. This is as nearly complete in its coverage as one could hope a psychological dictionary to be. In fact, it reminds us of a good many words (*adiadochokinesis, traumatophilic diathesis, nyctalopia*!) which one had hoped had achieved oblivion. The standard terms are defined with impeccable care and clarity, and terms which have not yet achieved a standard usage are supplied with carefully distinguished alternative meanings. The system of abbreviations, typographical aids, cross references, and so forth, can be easily mastered in a few minutes. As a dictionary this will prove invaluable to all students of psychology and related sciences.

What delights the reader, however, is that it is so much more than a dictionary; it is also interesting and absorbing. English loves the language that bears his name and loves the science that he is trying to rescue from confusion and ambiguity. He reminds us gently that *data* and *phenomena* are not singular; he waxes more than a little sarcastic when he deals with the artificially constricting meanings that have been thrust upon innocent everyday words, as in the case of the "information theory" jargon (not a "theory," he pauses to point out); and when a really confused term comes up, like *behavior,* or *learning,* or *operational,* or *phenomenology,* he is likely to launch into a carefully reasoned disquisition on the subject that is both fascinating and illuminating. One is reminded of experiences with Fowler's *Modern English Usage* when one has turned to the volume for a single item, only to find an hour later that one has been reading article after article for the sheer enjoyment of it. English may never achieve the eminence of *Fowler,* but he has certainly made a distinguished contribution to the clarification of psychological thinking.

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**Asian Perspectives.** The bulletin of the Far-Eastern Prehistory Association (American Branch), vol. 1, Nos. 1, 2. Wilhelm Solheim II, Ed. Far-Eastern Prehistory Association (University of Arizona, Tucson), 1957. 208 pp. $1.

Unpretentious in format, the first official publication of the Far-Eastern Prehistory Association (an offshoot of the Pacific Science Association) has as its avowed purpose the creation of interest in Far-Eastern prehistory. It plans to serve archeologists, physical and cultural anthropologists, historians, Sinologists, art historians, and others. Covering the Eastern Hemisphere east of India, the *Bulletin* deals with 20 regional areas of interest, ranging from broad geographical zones to separate states. Responsibility for each area is delegated to a regional editor. The fact that these areas include nations quite new politically as well as troubled older countries contributes to a state of unrest that is not entirely conducive to unhindered scientific research.

Following each of the regional résumés of recent events in the field is a bibliography of newer publications. Care is taken not to overlap too much with the publications of the Council for Old World Archaeology. This is a worthwhile little bulletin, and I wish it success.

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**Introduction to Riemann Surfaces.** George Springer. Addison-Wesley, Reading, Mass., 1957. viii × 307 pp. $9.50.

The theory of Riemann surfaces has its origin in the need to create a suitable domain of definition for a function $w$ of a complex variable $z$ that satisfies a given relation. A preview of some of the difficulties that actually arise can be obtained by considering the simple example $w^2 = z$; a value of $z$ does not determine $w$ uniquely, and if $z$ varies continuously along a simple closed curve in the complex plane, a given root $w$ that varies continuously need not return to its

original value. Such a state of affairs is at least as intolerable for the physicist and engineer as for the mathematician; if a scientist is ever tempted to question the value of mathematical abstraction, he should find in this book some measure of proof of the thesis that it is out of such abstractions that the solutions to very practical problems are created.

The theory of Riemann surfaces requires for its comprehension a great deal of modern mathematics. The author assumes no such knowledge on the part of the reader; four of the ten chapters (2, 4, 5, and 7), entitled "General topology," "Covering manifolds," "Combinatorial topology," and "The Hilbert space of differentials," introduce the reader to basic ideas in modern mathematics. These chapters are not surveys of the respective subjects but rather carefully developed treatments, with selection of material judiciously made in terms of the over-all aim of the book.

Chapter 1 is largely intuitive in its mathematical approach; it seeks to familiarize the reader with fundamental questions at issue, drawing on problems from both mathematics and physics. Chapter 3 is more formal; it proceeds from the abstract definition of Riemann surfaces (given in Chapter 2) and power series to build the concept of the complete analytic configuration of the analytic function. But it is in the remaining four chapters—"Differentials and integrals," "Existence of harmonic and analytic differentials," "Uniformization," and "Compact Riemann surfaces"—that fundamentals of the theory are developed.

The author has done an excellent job on a difficult assignment. His book will be of great value to the mathematician and should prove equally valuable to many scientists.

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**How to Estimate the Building Needs of a College or University.** A demonstration of methods developed at the University of Minnesota. William T. Middlebrook. University of Minnesota Press, Minneapolis, 1958. 169 pp. Illus. $15.

This study of plant needs at the University of Minnesota up to the year 1970 originated in a commission set up by the state legislature in 1955 to study state building requirements. The staff assembled to undertake this long-range forecast at the state university rejected the customary procedure of calculating future requirements on a per-student square-foot basis. So general a measure was inadequate for the varied educational and research tasks of a great state university. Instead, the university undertook an elaborate inventory of existing facilities and space utilization as well as a careful projection for the future. The methods employed and the results realized are reported in this volume, by the well-known vice president for business administration of the university.

There is little in the analysis which is new to those who have been studying enrollment trends, space utilization, and plant requirements. What is impressive is the careful amassing of data for the various instructional programs and the realistic use of simple analytic tools to project future needs. For example, employing as its basic unit of measurement square footage per student station, the study envisages an improvement in space utilization as enrollments increase. With a 135 percent increase in students on the Minneapolis campus projected for the period 1954 to 1970, the report indicates a need for a 93 percent increase in laboratory space, a 44 percent increase in classroom space, a 92 percent increase in library space, a 132 percent increase in faculty offices, a 75 percent increase in research facilities, a 51 percent increase in administration space, and a 64 percent increase in plant operation facilities. The result is an expressed need for over 128 million dollars' worth of building and land expansion and rehabilitation between 1957 and 1969. One wonders how the state of Minnesota will meet this staggering, but undoubtedly worth-while burden.

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## New Books

*Satellites, Rockets and Outer Space.* Willy Ley. New American Library, New York 22, 1958. 128 pp. Paper, $0.35.

*Gestation.* Transactions of the fourth conference, 5–7 Mar. 1957, Princeton, N.J. Claude A. Villee, Ed. Josiah Macy, Jr. Foundation, New York, 1958. 216 pp. $4.50.

*Characterisation of Organic Compounds.* F. Wild. Cambridge Univ. Press, New York, 1958. 306 pp. $6.50.

*Spot Tests in Inorganic Analysis.* Fritz Feigl. Translated by Ralph E. Oesper. Elsevier, Amsterdam, rev. ed. 5, 1958 (order from Van Nostrand, Princeton, N.J.).

*Tables of Light-Scattering Functions.* Relative indices of less than unity, and infinity. R. H. Boll, J. A. Leacock, G. C. Clark, S. W. Churchill. Univ. of Michigan Press (for the Engineering Research Inst.), Ann Arbor, 1958. 368 pp. $9.50.

*The Vocabulary of Dentistry and Oral Science.* A manual for the study of dental nomenclature. George B. Denton. American Dental Assoc., Chicago, 1958. 215 pp.

*A Modern Approach to Organic Chemistry.* J. Packer and J. Vaughan. Oxford Univ. Press, New York, 1958. 983 pp. $13.45.

*Existence.* A new dimension in psychiatry and psychology. Rollo May, Ernest Angel, Henri F. Ellenberger, Eds. Basic Books, New York, 1958. 454 pp. $7.50.

*Isaac Newton's Papers and Letters on Natural Philosophy and Related Documents.* I. Bernard Cohen, Ed., assisted by Robert E. Schofield. Harvard Univ. Press, Cambridge, Mass., 1958. 514 pp. $12.50.

*Einführung in die Physik.* vol. II, *Elektrizitätslehre, Wellenlehre, Akustik, Optik.* P. Frauenfelder and P. Huber. Reinhardt, Basel, Switzerland, 1957. 504 pp. F. 28.50.

*American Agriculture: Geography, Resources, Conservation.* Edward Higbee. Wiley, New York; Chapman & Hall, London, 1958. 409 pp. $7.95.

*The Gyroscope.* Theory and applications. James B. Scarborough. Interscience, New York, 1958. 269 pp. $6.50.

*Fundamentals of High Polymers.* O. A. Battista. Reinhold, New York; Chapman & Hall, London, 1958. 150 pp. $5.50.

*Current Trends in the Description and Analysis of Behavior.* Nine lectures under the auspices of the department of psychology in the college of the University of Pittsburgh delivered during 11–12 March 1955 and 8–9 March 1956 in the Stephen Foster Memorial Auditorium. Robert Glaser *et al.* University of Pittsburgh Press, Pittsburgh, 1958. 242 pp. $4.

*Man and His Physical Universe.* Frank Covert Jean, Ezra Clarence Harrah, Fred Louis Herman. Samuel Ralph Powers, editorial collaboration. Ginn, Boston, ed. 3, 1958. 666 pp. $6.50.

*The Tissues of the Body.* An introduction to the study of anatomy. W. E. Le Gros Clark. Oxford Univ. Press, London, ed. 4, 1958. 427 pp. $9.75.

*Calculus of Finite Differences.* George Boole. J. F. Moulton, Ed. Chelsea, New York, ed. 4, 1957. 348 pp. $4.95.

*Other Worlds in Space.* Terry Maloney. Sterling, New York, 1958. 128 pp. $2.95.

*Principles of Genetics.* Edmund W. Sinnott, L. C. Dunn, Theodosius Dobzhansky. McGraw-Hill, New York, 1958. 473 pp. $6.75.

*1001 Questions Answered about Astronomy.* James S. Pickering. Dodd, Mead, New York, 1958. 431 pp. $6.

*Space Book for Young People.* Homer E. Newell, Jr. Whittlesey House, New York, 1958. 114 pp. $2.95.

*Living Silver.* Burns Singer. Houghton Mifflin, Boston; Riverside Press, Cambridge, Mass., 1958. 232 pp. $3.75.

*Principles of Modern Physics.* A. P. French. Wiley, New York; Chapman & Hall, London, 1958. 364 pp. $6.75.

*How to Live with Diabetes.* Henry Dolger and Bernard Seeman. Norton, New York, 1958. 192 pp. $3.50.

*Frontiers in Cytology.* Sanford L. Palay. Yale Univ. Press, New Haven, Conn., 1958. 541 pp. $9.75.

*A Handbook of Lattice Spacings and Structures of Metals and Alloys.* W. B. Pearson. Pergamon Press, New York and London, 1958. 1054 pp. $38.

*Enzymes.* Malcolm Dixon and Edwin C. Webb. Academic Press, New York, 1958. 815 pp. $16.

# Reports

## Induction of Polyhedral Bodies in Ovarian Tissues of the Tussock Moth in vitro

Polyhedral virus diseases in various lepidopterous larvae have been induced by varying the physical conditions under which the insects live (for example, by crowding them or by subjecting them to high relative humidity) (*1*) or by feeding them compounds such as nitrites (*2*) or acetoxime (*3*). The only study of a polyhedral virus in insect tissues grown in vitro is that of Trager (*4*), in which he observed multiplication of polyhedral bodies in the nuclei of cells from the ovarian lining of the silkworm (*Bombyx mori*).

In a series of experiments (*5*) primarily set up to test the effects of various concentrations of Eagle's basal medium (*6*) on the growth of the ovarian tissue of the tussock moth (*Hemerocampa leucostigma*), polyhedral bodies appeared in some of the cultures after a change was made in the media used. A polyhedral virus disease in larvae of the tussock moth was reported by Chapman and Glaser in 1915 (*7*).

The tissues were obtained from last instar larvae growing on sycamore trees. Usually the larvae were sacrificed within 2 to 3 hours after collection. No evidence of any disease was noticed at the time of collection or on examination of the organs and blood on dissection. After the larvae had been surface-sterilized with 70-percent alcohol, the ovaries were removed, freed of nonovarian tissue, and cut into pieces about 1 $mm^3$ in size. The explants were selected at random when the cultures were set up. Each culture consisted of one explant in 0.005 ml of medium set up in a hanging-drop. The cultures were incubated at 26°C.

Five media were used in the experiment. The control cultures were grown in Wyatt's medium (*8*) modified by Grace (*9*), to which had been added 3-percent plasma obtained from diapausing pupae of the promethea moth (*Callosamia promethea*). The four experimental media consisted of 2- and 3-percent Eagle's solution in (i) Wyatt's medium containing 3-percent plasma and (ii) Wyatt's medium without plasma. These four media will be designated 2Ep and 3Ep and 2E and 3E, respectively. Six cultures were set up in each medium. Three days later a new series of cultures was set up containing 10- and 20-percent Eagle's solution in Wyatt's medium with plasma (10Ep and 20Ep) and Wyatt's medium without plasma (10E and 20E).

On examination of the cultures 5 days after initiation, the cultures containing blood showed very good growth, but the growth was poor in the cultures with no blood. In order to save the latter cultures, the media 2E and 3E were replaced, respectively, with 10- and 20-percent Eagle's solution with blood. These cultures were designated 2E-10Ep and 3E-20Ep.

In all the cultures in which the medium had been changed, it was noticed 4 days later that many of the nuclei were filled with granules. The cytoplasm remained clear and free of these bodies. Within the next 3 days every cell had become infected and many nuclei had burst, liberating the granules into the medium (Fig. 1). When examined under the dark field of the microscope, the granules were observed to be highly refractile and polyhedral in shape and to resemble the typical polyhedral bodies found in other insect polyhedral diseases. All the other cultures continued to grow, and the cells showed no evidence of any nuclear granulation.

To determine whether these bodies would multiply in cultures not subjected to a change in medium, two cultures from each of the groups 3Ep and 20Ep were inoculated with granules from a culture 3E-20Ep. The remaining four cultures in each group acted as controls. Four days later, nuclei in each inoculated culture were filled with granules, and by the sixth day after infection every nucleus in every cell showed infection and many of the cells had burst. No infection was noticed in the control cultures.

Granules from these cultures were transferred to healthy cultures of the series 2Ep and 10Ep, and four cultures in each series were again used as controls. By the seventh day after introduction of the granules, every cell was infected. None of the controls showed any infection.

As is generally recognized, the various polyhedral diseases of insects are highly specific and only in a very few cases are they able to be transmitted to other (even closely related) species. It was therefore decided to test whether the granules were capable of multiplying in cells from the ovarian tissue of the promethea moth. Three cultures of this species, which had been growing for 20 days, were inoculated with the granules from one of the cultures 3E-20Ep. Three sister cultures were used as controls. In no instance were any granules observed within the nuclei, even 17 days after the inoculation.

It is necessary to emphasize the following points. (i) On gross and microscopic examination, both before and after dissection, no evidence of infection was seen in any of the larvae used. (ii) Explants were chosen at random when the cultures were set up. (iii) No evidence of infection was noticed in any culture prior to the change of medium. (iv) Only those cultures in which the medium had been changed showed infection; all other cultures continued to grow, and the cells remained healthy.

To account for the phenomenon observed, it is postulated that the larvae used in this experiment carried a latent infection of a polyhedrosis which became

Fig. 1. Ovarian cells showing polyhedral bodies confined to nucleus, seventh day of infection. (About × 93) [Photograph by J. A. Carlile]

All technical papers are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

manifest after the cultures were subjected to a "physiological shock" brought about by an abrupt change from one medium to another.

Because it was late in the season, it was not possible to inject some of the granules into larvae to observe whether symptoms of a typical polyhedral disease developed. Electron microscope studies of the granules are now in progress (*10*).

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### References and Notes

1. R. C. Wallis, *J. Econ. Entomol.* 50, 580 (1957).
2. K. Yamafuji and F. Yoshihara, *Enzymologia* 15, 14 (1951).
3. K. Yamafuji and H. Omura, *Enzymologia* 14, 120 (1950).
4. W. Trager, *J. Exptl. Zool.* 71, 489 (1935).
5. This work was supported in part by a research grant (No. E-1537) from the National Institutes of Health, U.S. Public Health Service.
6. H. J. Eagle, *J. Exptl. Med.* 102, 595 (1955).
7. J. W. Chapman and R. W. Glaser, *J. Econ. Entomol.* 8, 140 (1915).
8. S. S. Wyatt, *J. Gen. Physiol.* 39, 841 (1956).
9. T. D. C. Grace, *Australian J. Biol. Sci.*, in press.
10. A paper describing these studies, as well as observations on the development of the disease in larvae, is in preparation.
* On leave of absence from the Division of Entomology, Commonwealth Scientific and Industrial Research Organization, Australia, February 1957–February 1959.

10 March 1958

## Atomic Bomb Effect: Variation of Radiocarbon in Plants, Shells, and Snails in the Past 4 Years

The measurements reported in this paper were primarily designed for a study of the activity of recent organic and inorganic material in various environments. They also gave evidence, however, of a fast increase of the activity of $C^{14}$ in the atmosphere due to atom bombs.

The first group of samples consisted of mussels from the Dutch Waddenzee (*Mytilus edulus*). They are indicated by *Ms* (shells) and *Mf* (Flesh). The second group consisted of land snails (*Helix pomatia*) from a snail farm in Valkenburg (province of Limburg). They are indicated by *W*. The third group consisted of fresh water molluscs (*Dreissenia polymorpha* Pallas) and an alga (*Tolypellopsis stelligera* (Bauer) Migula, family Characeae), collected by G. P. H. van Heusden in the lakes at Loenen (province of Utrecht). These samples are indicated by *Ls* and *Lf* for the dreissenia and by *Lp* for the plant. The lake water contained, on the average, 104 mg of $HCO_3^{--}$ per liter and about 1 mg free $CO_2$ per liter. The recent calibration sample (*P*) consisted of peanut shells bought in March 1955. These shells probably grew in the summer of 1954. Because of the fast rise in the concentration of $C^{14}$ in the past few years, it is also of importance to give the dates of collection of the other samples; *W*53, *M*, and *L* were collected in the second half of November, 1953; *W*56 on 15 Nov. 1956; and *W*57 on 18 June 1957. The snails collected in November were in a hibernating state.

The activities shown in Table 1 are given by their difference $\delta$ from the standard *P* in permillage of the activity of the standard. Each sample has been measured at least twice. The statistical error was between 0.2 and 0.3 percent. This is also the error in $\delta$ since the standard *P* has been measured several times.

As a check on fractionation during growth, and so forth, the concentration of $C^{13}$ has been measured (*1*). The results are given in Table 1 by the deviation from the standard *P*. Though some of the measurements were certainly accurate to better than 0.1 percent, sometimes irregularities occurred. Since all measurements were duplicated at least once, the error in $\delta\ C^{13}$ is estimated to be less than 0.1 percent.

*Recent increase of concentration of radiocarbon.* In looking at the activity *Wf* of the flesh of *Helix pomatia*, which is in fairly fast exchange with the plants the animal lives on, a remarkable increase by 4.3 percent is observed between November 1953 and June 1957. This increase can be due only to production of $C^{14}$ by atomic bombs. A similar effect has been observed in New Zealand (*2*) by a study of $CO_2$ samples immediately taken from the atmosphere. The increase of the activity of the shells (*Ws*) is only about 1 percent; obviously the carbonate in the shell does not exchange with the environment; the greater part of the shell was deposited in the period of lower $C^{14}$ concentration, but this fraction is difficult to estimate. The owner of the snail farm claims that at least some of the snails may have been up to 10 years old, but a somewhat lower limit is more probable. The lower activity of *Ws*56 as compared with *Ws*53 may be due to a higher age of these shells; it is not possible to check this, however. Furthermore, the activity of *Ws*53 is also too low. These shells contain 1.6 percent more $C^{13}$ than the flesh does. Thus they should contain 3.2 percent more $C^{14}$ (see also below). This is not true at all for the more recent shells where the fast increase of atomic bombs has produced a fast increase of activity in the flesh. The flesh is even more active than the shell. But already by 1953 the flesh was only 1 percent less active, instead of 3.2 percent. This discrepancy has puzzled us for a long time; it probably means that the bomb had produced an increase of about 2 percent by the end of 1953. This is being checked by collection of more appropriate samples. Since the flesh of *Helix pomatia* has the same $C^{13}$ content as the peanut shells, the two should have the same $C^{14}$ content. The difference is probably due to the fast increase of $C^{14}$ in the atmosphere between the two dates of collection, though it is not completely certain that geographic differences have not played a role.

The discrepancy between the enrichment of $C^{14}$ and $C^{13}$ in the shell does not occur for the mussels and the dreissenia. For the mussels this will be mainly due to the fact that the increase of $C^{14}$ concentration in the ocean is much slower. New samples were collected in November 1957 from the same locality in order to obtain some information, which is very important for discussions on exchange between the ocean and atmosphere. The activity proved to be only $0.5 \pm 0.3$ percent above the activity in 1953. The dreissenia shells were at most 1 year old, and this may explain why no discrepancy occurred.

*Isotopic fractionation.* Organic and inorganic carbon in the same environment can have different isotopic composition by fractionation in chemical and physical processes. Generally the fractionation is small; then the enrichment of $C^{14}$ should be twice the enrichment of $C^{13}$. It has been mentioned already above that this does not hold for *Helix pomatia*. The relation is nicely confirmed by the measurements on the three samples from the *Loenensche plassen* (*Ls*, *Lf*, and *Lp*) and the same is true for the samples *Ms* and *Mf*. It is of biochemical interest to note that the fractionation between shell and flesh is not the same for the three animals.

*Difference of environment.* It is obvious that the *Loenensche plassen* have a low $C^{14}$ content; this had been expected because of the transport of old

Table 1. Summary of results. The notations for the samples are given in the text.

| Sample No. | $\delta\ C^{14}$ (per mil) | $\delta\ C^{13}$ (per mil) |
|---|---|---|
| *P* | *0* | *0* |
| *Ws*53 | −11 | +16 |
| *Wf*53 | −21 | 0 |
| *Ws*56 | −17 | * |
| *Wf*56 | +18 | * |
| *Ws*57 | − 2 | * |
| *Wf*57 | +22 | * |
| *Ms*53 | −13 | +19 |
| *Mf*53 | −50 | + 4 |
| *Ls*53 | −44 | ~+25 |
| *Lf*53 | −94 | ~ 0 |
| *Lp*53 | −82 | ~+ 8 |

* The various batches of *Helix pomatia* (*W*) all gave the same concentration of $C^{13}$.

carbon with upwelling water into these lakes. The activity of the upwelling water alone is probably about 20 percent below the recent activity (*3*). The activity actually found is about 8 percent below normal; it is not possible to apply a correction for fractionation, for there is probably also no equilibrium for the $C^{13}$ content of the lakes and the atmosphere.

The difference in the $C^{14}$ concentration of the atmosphere and the ocean is of considerable interest. The present measurements may add some information to the data discussed previously in the literature (*5*). The new data cannot be fitted into the picture, however, before an international $C^{14}$ standard is available. Such a standard will permit the expression of all activities relative to the same standard.

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**References and Notes**

1. I acknowledge the measurement of the $C^{13}/C^{12}$ ratio to Dr. Ir. H. Boerboom and Mr. F. Monterie, Laboratorium voor Massaspectrografie, Amsterdam. For technical details see: *Appl. Sci. Research* B5, 388 (1957).
2. T. A. Rafter and G. J. Fergusson, *Science* 126, 557 (1957).
3. K. O. Münnich, *Naturwissenschaften* 44, 32 (1957).
4. H. Craig, *Tellus* 9, 1 (1957).
5. R. Revelle and H. E. Suess, *ibid.* 9, 18 (1957).

11 February 1958

## Some Kinetic Parameters of Liver Glucose-6-Phosphatase in Normal and Diabetic Rats

Several laboratories have recently reported an increase in the activity of liver glucose-6-phosphatase in the diabetic animal (*1–4*) and in animals subjected to increased levels of adrenal cortical hormones (*2, 3, 5*). Insulin appeared to reverse the effect in the diabetic animal within 12 to 48 hours (*1, 2*). Ashmore *et al.* (*1*) further observed that mixtures of normal and diabetic rat liver homogenates possessed additive activities. This fact suggested that the difference was not due to the presence of an inhibitor in normal liver or an activator in diabetic liver, although the possibility of limited amounts of a tightly bound activator or inhibitor is not entirely eliminated. We have undertaken an investigation of the comparative properties of normal and diabetic rat liver glucose-6-phosphatase with the view that the results might bear on the problem of the biochemical mechanism whereby the hormonal effects are mediated (*6*).

In general, there appear to be two underlying enzymic mechanisms which could account for the elevated glucose-6-phosphatase activity in the diabetic animal. Either more of the normal enzyme may be present, or the amount of enzyme present may be unchanged but its properties altered in the direction of an increase in catalytic potency (or a combination of both). The latter implies some structural change in the enzyme which would presumably be manifested in one or more measurable properties. In this connection, the very obvious possibility of an increase in the rate constant for the decomposition of the enzyme-substrate complex into products ($k_3$) must await extensive purification of the enzyme before it can be tested. However, several kinetic parameters, such as the Michaelis constant ($K_s$), the equilibrium constant for inhibitor binding ($K_i$), and the enthalpy of activation of the reaction ($\Delta H^*$) can be measured even in a crude system (bearing in mind the possibility that other substances present in the enzyme preparation might affect the values of these parameters). In all of the experiments reported here, conditions were employed in which it had previously been established that the amount of product liberated was proportional to time, the velocity was proportional to enzyme concentration, and the stoichiometry was that expected.

In Fig. 1 are presented the entire series of determinations of apparent Michaelis constants ($K_s$) and maximum velocities at infinite substrate concentration ($V_m$) of the liver glucose-6-phosphatase of normal rats of the Carworth strain and their diabetic litter mates (*7*). Several groups of animals, and both males and females, are included in the series. The diabetic animals had been injected subcutaneously with 20 mg of alloxan monohydrate per 100 g at least 3 weeks previous to sacrifice; they had blood sugar concentrations of at least 400 mg/100 ml. From Fig. 1 it can be seen that the average $K_s$ of the diabetic animals was almost twice as great as that of the normal animals, and that there was very little overlap in the values. In addition, a marked linear correlation between the $K_s$ and $V_m$ values for individual animals is apparent ($r = 0.87$). An alteration in $k_3$ produces a relationship of this kind (*8*).

The $\Delta H^*$ values of the reactions catalyzed by the normal and diabetic enzymes over the range 25° to 40°C were 12,480 cal and 16,700 cal, respectively, at a substrate concentration of $0.01M$. The thermal instability of glucose-6-phosphatase at 37°C and *p*H 5.0, which has been reported for the normal enzyme (*9*), was also found in the case of the diabetic enzyme.

Studies of the kinetics of glucose inhibition revealed that the inhibition was of a noncompetitive nature (Fig. 2). The possibility that this effect was the result of an exchange between the substrate and the inhibitor was tested and excluded. The $K_i$ of glucose binding was 0.11 to $0.15M$ (av. $0.12M$) for the enzyme from four normal animals, and 0.11 to $0.18M$ (av. $0.13M$) for the enzyme from seven diabetic animals (*10*).

The results reported here make it clear that while there is an increased *capacity* of the diabetic liver to hydrolyze glucose-6-phosphate, as expressed by the activity per milligram of tissue at high substrate concentration ($V_m$), the

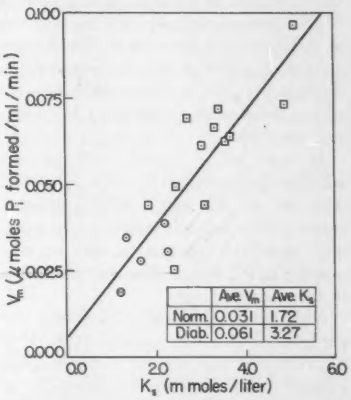


**Fig. 1. Kinetic parameters of normal and diabetic liver glucose-6-phosphatase. The normal values are shown by circles, the diabetic by squares. Each value was calculated by the method of least squares from the initial velocities at four to six initial substrate concentrations over the range 1 to 30 μmole/ml of K glucose-6-phosphate (see Fig. 2). In addition, each milliliter of reaction mixture contained 0.3 ml of $0.25M$ sodium cacodylate (*p*H 6.4) and 2.5 mg of liver homogenate. Incubation was for 10 min at 30°C with shaking. Inorganic phosphate ($P_i$) was determined by the Fiske-Subbarow method. The slope of the line of best fit through the points is $0.017 \pm 0.002$ $min^{-1}$.**

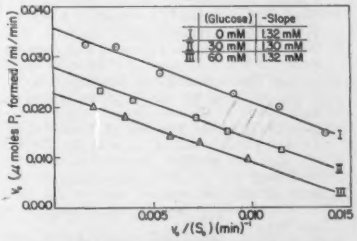


**Fig. 2. Glucose inhibition. Incubation conditions were the same as those shown for Fig. 1, except that glucose was added to initial concentration indicated. Initial velocity is plotted against initial velocity divided by initial substrate concentration. Slopes were calculated by the method of least squares.**

actual difference between the rates of hydrolysis of glucose-6-phosphate in the diabetic and normal liver decreases progressively as the substrate concentration diminishes. For example, from the average $K_s$ and $V_m$ values given in Fig. 1, it can be calculated that at a glucose-6-phosphate concentration of 10 m*M* the rate of hydrolysis per milligram of tissue is about 75 percent more rapid in the diabetic liver than in the normal liver, whereas, at a substrate concentration of 1 m*M* the difference is about 25 percent. It is obvious that any extension of differences in glucose-6-phosphatase activities observed in vitro to an explanation of the altered carbohydrate metabolism of the diabetic liver must be based upon an actual difference in the rate of hydrolysis of glucose-6-phosphate in vivo rather than upon a difference in potential capacity.

It will be of interest to discover whether the increased $K_s$ values observed with the enzyme from diabetic animals represents an intrinsic difference in property which is retained in the purified enzyme or is a result of an altered milieu in the diabetic liver.

*Note added in proof.* In recent experiments it has been found that the high $K_s$ values of the enzyme from diabetic animals was restored to the normal level after 48 hours of insulin treatment, and the $V_m$ values were also markedly decreased (*11*).

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### References and Notes

1. J. Ashmore, A. B. Hastings, F. B. Nesbett, *Proc. Natl. Acad. Sci. U.S.* 40, 673 (1954).
2. R. G. Langdon and D. R. Weakley, *J. Biol. Chem.* 214, 167 (1955).
3. J. Ashmore, A. B. Hastings, F. B. Nesbett, A. E. Renold, *J. Biol. Chem.* 218, 77 (1956).
4. R. G. Langdon and D. R. Weakley, *Federation Proc.* 16, 208 (1957).
5. G. Weber, C. Allard, G. de Lamirande, A. Cantero, *Endocrinology* 58, 40 (1956); K. H. Shull, G. Cahill, Jr., E. L. Gadsden, J. Mayer, *J. Biol. Chem.* 222, 415 (1956).
6. This investigation was supported by a research grant (A-875, C-2) from the National Institutes of Health, U.S. Public Health Service.
7. Values of 2 m*M* for the $K_s$ of the glucose-6-phosphatase of the microsome fraction of rat liver [R. K. Crane, *Biochim. et Biophys. Acta* 17, 443 (1955)], and of 2.5 m*M* for the $K_s$ of partially purified glucose-6-phosphatase from dog liver (*4*) have been reported. We have obtained an average value of 3.2 m*M* for the enzyme in homogenates of eight normal dog livers.
8. E. C. Slater, *Discussions Faraday Soc.* 20, 231 (1955).
9. H. Beaufay and C. de Duve, *Bull. soc. chim. biol.* 36, 1525 (1954).
10. Langdon and Weakley (*4*) have reported a *competitive* inhibition by glucose for the partially purified enzyme from dog liver, with a $K_i$ of 0.029*M*.
11. A paper describing the details of these experiments is in preparation.

25 February 1958

## Method for Adapting the Virus of Rinderpest to Rabbits

The difficulty of adapting the virus of rinderpest to rabbits by serial passage is well known. Baker (*1*) succeeded in adapting the rinderpest virus to rabbits by alternating the inoculations between calves and rabbits. The calf served to maintain sufficient virus in the inocula to overcome the threshold of infection in the rabbits. After a number of alternations sufficient adapted virus was produced to assure the maintenance of serial passage infections.

Shope *et al.* (*2*) have shown that the minimal infective dose of rinderpest virus for the chorioallantoic membrane is roughly in agreement with the subcutaneous minimal infective dose of virus for the calf. It was, therefore, thought that the chorioallantoic membrane might be substituted for the calf in the alternate passing referred to above. With this in mind an experiment was conducted in which a virulent strain of rinderpest virus was successfully adapted to the rabbit. Although this method has no particular advantage other than economic over that evolved by Baker, it is possible that it might be of value in the study of other viruses.

The Kabete strain of rinderpest virus was propagated on the chorioallantoic membrane through 45 serial transfers after the manner described by Shope *et al.* Calf inoculations of earlier passage membranes usually resulted in death on the 8th, 9th, or 10th day. Chorioallantoic membranes from the 42nd passage eggs were inoculated into a calf, and there was no evidence of attenuation of the virus.

Rabbits of various breeds were employed. Only healthy, mature subjects whose normal temperature fell in the range of 102 to 103.5°F were selected for the experiment. The fertile eggs employed were from a healthy flock of mixed breeds.

The inoculum of chorioallantoic membranes for each rabbit consisted of 2.0 ml of a suspension of three chorioallantoic membranes comminuted in 3.0 ml of allantoic fluid. The rabbit spleen suspensions were prepared by grinding each rabbit spleen in 9.0 ml of normal saline. The amount of this suspension deposited on each chorioallantoic membrane was 0.3 ml. None of the tissue suspensions were centrifuged, and the rabbit inoculations (all intravenous) were made slowly in order to avert shock. The 10-day embryonated eggs were incubated for 4 days, and all rabbits whose spleens were employed for inocula were electrocuted on the fourth day after injection.

1) The series of inoculations was begun by inoculating 43rd passage chorioallantoic membranes into rabbit No. 1. The highest temperature recorded was 104.8°F. The spleen from rabbit No. 1 was inoculated on to the first group of chorioallantoic membranes.

2) The first group of membranes was inoculated into rabbits No. 2 and 3. The peak temperature of the former was 103.9°, and that of the latter 104.1°. The spleen from rabbit No. 3 was inoculated on to the second group of chorioallantoic membranes.

3) The second group of membranes was inoculated into rabbits No. 4 and 5. Rabbit No. 4 died as a result of shock. Rabbit No. 5 had a peak temperature of 104.6°. The spleen was inoculated on to the third group of chorioallantoic membranes.

4) The third group of membranes was inoculated into rabbit No. 6. The highest temperature was 104.0°. The spleen was inoculated on to the fourth group of chorioallantoic membranes.

5) The fourth group of membranes was inoculated into rabbit No. 7.

The inoculations were then continued serially in rabbits. The spleen from rabbit No. 7 was inoculated into rabbits No. 8 and 9. The highest temperatures were 103.4° and 104.1° respectively.

The spleen from rabbit No. 9 was inoculated into rabbit No. 10. The highest temperature recorded was 106.2°. The spleen from this rabbit was inoculated into rabbits No. 11 and 12. The post-injection temperatures are listed in Table 1.

The spleen of rabbit No. 12 was removed and each of two calves was given 1.0 ml of a 1:10 dilution in saline.

Calf No. 1, which had been previously immunized against rinderpest, showed no evidence of the disease.

Calf No. 2, which had not been immunized, succumbed to characteristic rinderpest in 12 days. The first high temperature was recorded on the third day following injection, indicating that there was considerable amount of virus present in the spleen of rabbit No. 12.

The temperature curves of rabbits 10, 11, and 12 for the 96-hour postinjection period conformed in general with a typical curve drawn by Baker. These rabbits also exhibited substantially the same signs of illness and gross pathology as Baker observed in his rabbits of comparable passages, except that rabbits 11 and 12, but not rabbit 10, displayed a considerable number of small white foci in the swollen Peyer's patches, sacculus rotundus, tonsilla cecalis major, and appendix. The number of white foci was not as great in either rabbit as is usually observed in rabbits injected with the Nakamura lapinized strain.

Although 43rd-passage membrane virus was employed to initiate the alter-

Table 1. Temperatures recorded in rabbits inoculated with rinderpest virus.

| Time after injection (hr) | Temperature (°F) | |
|---|---|---|
| | Rabbit 11 | Rabbit 12 |
| 24 | 102.5 | 102.8 |
| 32 | 103.3 | 104.5 |
| 48 | 105.6 | 106.5 |
| 56 | 106.0 | 107.0 |
| 72 | 102.8 | 103.9 |
| 80 | 103.0 | 103.2 |
| 96 | 102.4 | 103.1 |

nate transfers, it seems likely that earlier passage membranes could be used with equal success. Titrations of fourth- and ninth-passage membranes have shown the virus to be present in considerable amounts (*2*). No doubt, if a sufficient number of serial passages were carried out in the rabbit, the virus would eventually become attenuated for the calf (*3*).

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**References and Notes**

1. J. A. Baker, *Am. J. Vet. Research* 7, 179 (1946).
2. R. E. Shope, H. J. Griffiths, D. L. Jenkins, *Am. J. Vet. Research* 7, 135 (1946).
3. This work was a joint project of the Grosse Ile Experimental Station, Defence Research Board of Canada, and the Animal Pathology Division, Canada Department of Agriculture, Animal Disease Research Institute, Hull, Quebec. It was conducted under the direction of C. A. Mitchell, director of projects.

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6 March 1958

## Enzymatic Synthesis of Adenyl-oxyluciferin

In the activation of amino acids, acetic acid, and firefly luciferin by adenosine triphosphate (ATP), pyrophosphate and the corresponding acyl-adenylates are presumably formed (*1*). The synthetic adenylates in all three cases are biologically active. Unfortunately, the enzymatic synthesis of these acyl-adenylates has not been demonstrated. Presumably this is due to the tight binding of the adenylates to the enzyme. Recently we have been able to measure the equilibrium constant for the association of adenyl-oxyluciferin (L-AMP) and firefly luciferase. As expected, it was found that the equilibrium constant of the reaction

$$\text{L-AMP} + \text{E} \rightleftarrows \text{E-L-AMP}$$

was approximately $2 \times 10^9$. Apparently a similar tight binding with enzyme exists with regard to the amino acid and acetic acid adenylates. If this is true, it is not surprising that it has been difficult to demonstrate the enzymatic formation of the adenylates of these compounds. However, the intense fluorescence of oxyluciferin makes it possible to measure the disappearance of quantities which are less than the amount of enzyme added. Because of this sensitivity of the fluorescence technique, we have been able to measure the enzymatic formation of L-AMP in the following reaction:

$$\text{ATP} + \text{L} + \text{E} \rightleftarrows \text{E-L-AMP} + \text{POP} \quad (1)$$

The measurement of L-AMP synthesis depends on the following differences in properties between chemically synthesized L-AMP and oxyluciferin: (i) L-AMP has a fluorescence intensity which is only 2 percent of the intensity of oxyluciferin. (ii) At a *p*H of 3 oxyluciferin is extractable into ethyl acetate, whereas L-AMP is not. The solubility of the oxyluciferin in ethyl acetate depends upon the dissociation of the carboxyl group. (iii) When paper chromatography and the solvent system described in Table 1 are used, L-AMP has an $R_f$ of 0.55, while oxyluciferin has an $R_f$ of 0.40.

The results of an experiment in which oxyluciferin, luciferase, $MgSO_4$ and ATP were incubated at *p*H 7.1 are shown in Table 1. The reaction was initiated with ATP. Following the addition of ATP there was an immediate decrease in fluorescence corresponding to the disappearance of oxyluciferin approximately equal to the amount of luciferase present. When the reaction mixture was acidified and extracted with ethyl acetate, the excess oxyluciferin was removed from the reaction mixture. The nonextractable, weakly fluorescent material in the aqueous phase had an $R_f$ of 0.55 which is identical to that of synthetic adenyloxyluciferin. Alkaline hydrolysis gives an increase in the fluorescent intensity and a product with an $R_f$ of 0.4. This, and other evidence which has been recently published, indicates clearly that the material in the aqueous phase is adenyl-oxyluciferin (*2*).

By fluorescence measurements, it has been possible to determine equilibrium concentration of oxyluciferin from which the equilibrium constant for reaction 1 can be calculated. It should be noted that in this reaction the enzyme must be considered in the equilibrium determination. Measurements made on the forward and reverse reactions both give a value of $K$ approximately equal to $2.0 \times 10^8$. By using this constant, along with the dissociation constant for luciferase-L-AMP complex, the free energy of hydrolysis of L-AMP can be calculated. If it is assumed that the free energy of hydrolysis of the second phosphate bond in ATP is the same as for the terminal phosphate bond (*3*), the free energy of hydrolysis is obtained by adding the following reactions:

Table 1. Results. The reaction mixture contained the following: oxyluciferin, 3.2 mμmole; $MgSO_4$, 10 μmole; luciferase, 2.0 mμmole; ATP, 4 μmole; brought to final volume of 2.0 ml with 0.1*M* tris-maleate buffer, *p*H 7.1.

| Reaction mixture | Fluorescence* intensity | $R_f$ |
|---|---|---|
| − ATP | 80 | 0.40 |
| Complete | 30 | 0.55† |

* Arbitrary units; excitation, 360 mμ; emission, 540 mμ.
† After ethyl acetate extraction; paper Whatman No. 3-MM; solvent, 30:70 (by volume) mixture of 1*M* ammonium acetate and 95 percent ethanol, *p*H 7.5.

| | $\Delta F°$ (kcal) |
|---|---|
| $\text{ATP} + \text{L} + \text{E} \rightleftarrows \text{E-L-AMP} + \text{POP}$ | − 7.2 |
| $\text{E-L-AMP} \rightleftarrows \text{E} + \text{L-AMP}$ | + 12.6 |
| net $\text{ATP} + \text{L} \rightleftarrows \text{L-AMP} + \text{POP}$ | + 5.4 |
| $\text{POP} + \text{AMP} \rightleftarrows \text{ATP} + \text{H}_2\text{O}$ | + 7.7 |
| net $\text{L} + \text{AMP} \rightleftarrows \text{L-AMP} + \text{H}_2\text{O}$ | + 13.1 |

These calculations were made on the assumption that $Mg^{++}$ has no appreciable effect on the equilibrium of the activation reaction. This point is now being investigated. It is not surprising that the free energy of hydrolysis of L-AMP is considerably higher than that of ATP, since coenzyme A reacts readily with L-AMP to produce AMP and oxyluciferyl-coenzyme A.

The biological significance of the tight binding of acyl adenylates to the enzyme is not clear. However, it should be pointed out that the present evidence indicates that such tight binding restricts the reactivity of the adenylates. For example, L-AMP is capable of reacting with SH compounds such as coenzyme A and cysteine to form the corresponding oxyluciferin derivatives and adenylic acid. However, cysteine is capable of reacting only nonenzymatically with L-AMP, whereas coenzyme A can react with L-AMP only when it is bound to luciferase (*4*).

*Note added in proof*: M. Karasek *et al.* have recently demonstrated the enzymatic synthesis of tryptophan-AMP (*5*).

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**References and Notes**

1. M. B. Hoagland *et al.*, *J. Biol. Chem.* 218, 345 (1956); J. A. DeMoss *et al.*, *Proc. Natl. Acad. Sci. U.S.* 42, 325 (1956); P. Berg, *J. Biol. Chem.* 222, 1015 (1956); E. W. Davie *et al.*, *Arch. Biochem. Biophys.* 65, 21 (1956); W. D.

McElroy and A. A. Green, *Arch. Biochem. Biophys.* 64, 257 (1956).
2. R. L. Airth, W. C. Rhodes, W. D. McElroy, *Biochim. et Biophys. Acta*, in press.
3. T. H. Benzinger and R. Hems, *Proc. Natl. Acad. Sci. U.S.* 42, 896 (1956).
4. This report is contribution No. 232 of the McCollum-Pratt Institute. The work was supported in part by a grant from the National Science Foundation.
5. M. Karasek *et al.*, *J. Am. Chem. Soc.* 80, 2335 (1958).

10 March 1958

## Test for Genetic Recombination in Kappa Particles of Paramecium aurelia, Variety 4

Kappa particles are microscopically visible structures, about a micron in length, which are distributed at random in the endoplasm of certain strains of paramecia. Furthermore, these particles, numbering several hundred per paramecium, are self-reproducing and mutable, and they contain deoxyribonucleic acid and are capable of infecting other paramecia under certain conditions (*1*). It is clear that the kappa particle shows many properties of a microorganism; hence, another property, genetic recombination, was also looked for.

At least two pairs of characters which do not lie at the same genetic locus must be studied to detect recombination. With kappa particles two such pairs are (i) ability, or lack of it, to produce the poison paramecin and (ii) ability, or lack of it, to persist in paramecia under certain culture conditions. The reason for assuming that these characters are not at the same locus is that they mutate independently of one another. Specifically, *slow hump kappa* particles (*2*) produce paramecin but are lost from animals grown at maximal fission rate at 31°C; *pi* particles (*3*) do not produce paramecin and are not lost under the growth conditions just described. Both types are mutants of the *normal hump kappa* particles found in stock 51 of *Paramecium aurelia*, variety 4. Normal hump kappa particles, like slow hump kappa, produce paramecin, but, like pi are not lost from well-fed paramecia grown at 31°C.

The test for recombination is to determine whether, following placement of slow hump kappa and pi particles in a common cytoplasm, there will appear particles capable both of producing paramecin and of persisting in host organisms grown at maximal rate at 31°C. That is, will normal hump kappa-like particles appear? This test was made as follows. Three types of paramecia, containing pi and slow hump kappa particles, containing only slow hump kappa particles, and containing only normal hump kappa particles, were all grown under conditions which would result in the marked decrease or loss of slow hump kappa particles, as indicated by a marked decrease or loss of poison production. Then the progeny of all three sets were tested for production of paramecin. The animals containing pi and slow hump kappa particles gave results comparable to those given by animals containing only slow hump kappa, both groups showing little or no paramecin production, whereas the normal hump kappa animals produced large amounts of the poison.

If the animals containing both pi and slow hump kappa particles had shown paramecin production similar to that of the normal hump kappa animals, then appearance of a recombinant type of particle in the former would be a possible explanation. In the absence of such a finding, the simplest conclusion is that under the conditions of this experiment no recombination occurs. This experiment assumed that the recombinant would behave as normal hump kappa do in the presence of pi—that is it would become abundant in each organism (*4*). However, it is possible that the recombinant might be of a new type which would exist only in a very low frequency. The experiment, as executed, does not test this possibility (*5*).

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### References and Notes

1. T. M. Sonneborn, *Proc. Natl. Acad. Sci. U.S.* 29, 329 (1943); *Am. Naturalist* 82, 26 (1948); R. V. Dippell, *Heredity* 4, 165 (1950); J. R. Preer, *Genetics* 35, 344 (1950).
2. E. D. Hanson, *Genetics* 39, 229 (1954).
3. ———, *Genetics* 41, 21 (1956).
4. ———, *J. Exptl. Zool.* 135, 29 (1957).
5. This article is contribution No. 647 from the Zoology Department of Indiana University. During the course of this investigation, I was a predoctoral fellow of the National Science Foundation. This work was aided in part by a grant from the Rockefeller Foundation for work in genetics at Indiana University, and in part by a grant-in-aid to Professor T. M. Sonneborn from the American Cancer Society upon recommendation of the Committee on Growth of the National Research Council.

3 March 1958

## Acetylcholine Hydrolysis in Psychiatric Patients

In a recent report (*1*) I suggested the possibility that the mechanism underlying the relationship between scotopic threshold changes and psychiatric disorders may be a deficiency in the acetylcholine-cholinesterase balance.

Granger (*2*) reported that schizophrenics manifested a significant elevation of the dark-adaptation curve along the log-luminance axis, without alteration of shape, as compared with normals. Rubin and Goldberg (*3*) employed Sarin (isopropyl methylphosphonofluoridate), an anticholinesterase, in experiments designed to determine the effect on scotopic visibility of measured quantities of inhaled material and found significant elevations of the absolute visual threshold. A second study (*4*) indicated that conjunctival instillation had no significant effect on dark adaption, while significant elevation of the dark-adaption threshold did occur when both eyes were protected from the atmosphere containing Sarin and in both eyes although only one had been protected. Rubin *et al.* (*5*) then performed another test of the hypothesis that the eventuation of the threshold response was localized in the central nervous system. Following exposure to Sarin, it was found that the tertiary atropine salt (atropine sulfate) reduced the elevated threshold to the preexposure level while the quaternary methosalt of atropine (atropine methyl nitrate) had no effect on the Sarin-produced elevated threshold. The ability of the tertiary salt to pass the blood-brain barrier while the quaternary salt does not suggested that the cholinergic blocking effect observed was acting centrally. It was further suggested that acetylcholine-cholinesterase concentrations are important determinants of the dark-adaption process. These results suggested that the elevated dark-adaptation thresholds observed in schizophrenia could be attributed to some biochemical imbalance between the enzyme and its substrate.

With this paradigm in mind, it was posited that the hydrolysis rate of acetylcholine by erythrocyte cholinesterase should be different for normals and for patients admitted to a psychiatric institute (*6*). Blood samples (5 ml) were obtained from 10 volunteers among the hospital staff and from 23 patients within 24 hours after admission and prior to the administration of any kind of therapy. Michel's electrometric method (*7*) was employed to determine the activity of the cholinesterase (*8*). The rate of hydrolysis of acetylcholine by erythrocyte cholinesterase for the normals and institutionalized patients is presented in Table 1. The standard error of regression for the normals was found to be $s_b = \pm 0.0003$, and the fiducial limits of the slope at the 5-percent level of confidence for $(n\text{-}2)df$ was found to be $l_1 = -0.0106$ and $l_2 = -0.0088$. The slope for each patient was calculated and then evaluated relative to the fiducial limits calculated for the normal sample. Six out of 23 patients had slopes that fell within the fiducial limits of the sample, while 17 distributed themselves into two groups that differed significantly from the linear regression that characterized the sample of normals. Ten patients showed significantly slower, and seven patients showed significantly faster, hydrolysis of acetylcholine by erythrocyte cholinesterase. Of the six patients whose slopes were in the normal hy-

Table 1. Linear regression equations and $\Delta p$H/min. for the normal subjects and the two groups of patients who differed significantly from the normals as well as from each other.

| Subjects | $n$ | Hydrolysis rate | Regression equation | $\Delta p$H/min |
|---|---|---|---|---|
| Patients | 10 | Slow | $Y = 7.917 - 0.0075X$ | −0.0075 |
| Normals | 10 | Normal | $Y = 7.906 - 0.0097X$ | −0.0097 |
| Patients | 7 | Fast | $Y = 7.922 - 0.0116X$ | −0.0116 |

drolysis range, it is interesting to note in passing that one is presently considered by the clinical staff to have an organic lesion as indicated by electroencephalographic examination, and five are considered by the clinical staff to have neurotic depressions. Sixteen patients were evaluated clinically as schizophrenic.

These preliminary data do not contradict my general hypothesis that acetylcholine-chloinesterase imbalance may be a biochemical concomitant of the so-called "functional psychoses." A disturbance in enzymatic kinetics which may be reflected in excessive cholinesterase activity or deficient enzyme activity may be responsible for the maladaptive behavior which characterizes those that comprise the schizophrenic syndrome group. Since some pharmacological agents are now available whose effects on the acetylcholine-cholinesterase cycle are well known, experiments will be conducted to determine the behavioral changes that follow pharmacological manipulation of the kinetics of this enzyme system and its substrate. Specifically, it is predicted that marked behavioral changes should accompany the administration of an anticholinesterase—that is, diisopropyl fluorophosphate—to an individual whose hydrolysis rate for acetylcholine is too rapid, as compared with normal values; moreover, the administration of cholinergic blocking agents should produce marked behavioral changes in those individuals who manifest slow hydrolysis of acetylcholine by erythrocyte cholinesterase.

Although several investigators have previously focused attention on the role of acetylcholine-cholinesterase balance in schizophrenia and manic depressive psychosis, one may infer from their work that the hypothesis tested was limited to the role of deficient acetylcholine levels. Thus Fiamberti (*9*) has reported improvement in some schizophrenic subjects when intravenous injections of acetylcholine were administered. Rountree et al. (*10*) increased acetylcholine levels by administering diisopropyl fluorophosphate to schizophrenics and manic depressives without noting significant improvement in all subjects. The findings of the present study suggest that the administration of anticholinesterases or parasympathomimetic drugs could be effective only for those patients who manifested a rapid rate of hydrolysis of acetylcholine by the erythrocyte cholinesterase. If we can assume that the slopes obtained from the samples are reliable estimates of regression for populations, then we can deduce that, approximately, only half of a functionally psychotic population, selected at random, could be favorably affected by the pharmacological stimulation of a pronounced cholinergic effect. The remaining half, manifesting slow hydrolysis, would require cholinergic blocking agents.

It is not necessary, at this time, to consider whether or not this biochemical mechanism is the invariable concomitant of the functional psychoses. The next step requires that studies be undertaken to determine whether predictable behavioral changes result from systematic variations of enzymatic kinetics produced by appropriate pharmacological agents.

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**References and Notes**

1. L. S. Rubin, in preparation.
2. G. W. Granger, *Science* **125**, 500 (1957).
3. L. S. Rubin and M. N. Goldberg, *J. Appl. Physiol.* **11**, 439 (1957).
4. L. S. Rubin, S. Krop, M. N. Goldberg, *J. Appl. Physiol.* **11**, 445 (1957).
5. L. S. Rubin and M. N. Goldberg, *J. Appl. Physiol.*, **12**, 305 (1958).
6. In order to circumvent poorly defined distinctions between normality, schizophrenia and neurosis, the comparison is made between individuals who, because of a complex of medicosocial factors, are admitted as patients to a psychiatric hospital as opposed to another population whose members lack those factors requisite for institutionalization.
7. H. O. Michel, *J. Lab. Clin. Med.* **34**, 1564 (1949).
8. I gratefully acknowledge the aid provided by Miss Helen Gerstein, of the Clinical Services Laboratory, who made all of the cholinesterase determinations.
9. A. M. Fiamberti, *Riv. patol. nervosa. e mentale.* **66**, 1 (1946).
10. D. W. Rountree, S. Nevin, A. Wilson, *J. Neurol. Neurosurg. Psychiat.* **13**, 47 (1950).

17 April 1958

## Measurement of Observing Responses in Human Monitoring

The variables involved in visual monitoring and vigilance tasks need description and analysis, especially the observation, detection, and control response variables. In the usual study, control responses are measured, and then detection of a signal and observation of the display are inferred. Recently, however, Holland (*1*) has shown that direct measures of observing responses can be obtained. His subjects worked in a dark room and were required to detect and report deflections of a pointer on a dial. The dial could be seen only when the subject illuminated it for a short time by depressing a key. Each key depression was defined as an observing response. A second key was depressed by the subject to record signal detections and to reset the pointer. Holland found that, under fixed-interval schedules of pointer deflections, after each detection, observing responses ceased for a time and then resumed in an accelerated manner until the next detection. This resulted in scallop-shaped records of the subject's observing rate which were analogous to those obtained in other operant conditioning experiments with infrahuman subjects (*2*).

Generally speaking, observing responses refer to the relation, through time, between sense-organ orientation and displays. The visual sense is most commonly employed by humans in monitoring tasks. While Holland's technique insured that the observing response permitted observation of the display, the depression of a key may or may not be the same as actual head and eye movements involved in monitoring tasks. The experiment described in this report was designed to obtain a measure of observing responses which, while not eye movements, is assumed to be highly correlated with them. These measures were compared with those obtained by Holland.

Five male employees of the Research and Development Division of Electric Boat served as subjects, and each was given ten 30-minute sessions on a fixed, 1-minute interval schedule. As in Holland's study, the subjects worked in a dark room and had to detect deflections of a pointer from a null position. Detection was recorded and the pointer was reset when the subject pushed a button; the pointer remained deflected until the button was pushed. A continuous light source fixed atop elastic headstraps worn by the subject permitted him to observe the dial and pointer. The presence of the light on the dial was defined as an observing response. These observing responses can be thought of not as movements but as fixations of "holding responses" where the light is held on the dial. The light source was a 2.25-v flashlight bulb (lighted by a 1.5-v battery) fixed in the rear of a tube 10 in. long and ¾ in. in diameter. This tube was fixed to the elastic headstraps. At a normal viewing distance of 28 in., the circle of light was 3 in. in diameter and had an intensity of 3 ft-ca.

Before each session the subject sat in a comfortable position with his eyes on the dial. The tube was then adjusted by

the experimenter so that the light fell on the dial behind which was a light-sensitive germanium diode. When the light fell on the dial, a recording pen was deflected. The pointer deflections and resets were also recorded.

Each subject was instructed to detect as many signals as he could and to reset the pointer as quickly as possible. At the end of each session each subject was told the number of signals he had detected and his reset times. No mention was made of the experimenter's interest in the observing responses, and subjects were told only that they could use the light to illuminate the dial.

Inspection of the records of the tenth session shows marked consistency of observing behavior within subjects but great differences between subjects. Data showing a portion of each subject's responses on session 10 are presented in Fig. 1.

The magnitude of deflection away from the "no-response" base line depended upon the proximity of the light to the dial, and it can be seen that there was both intra- and intersubject variability.

Two of the subjects, *S*-2 and *S*-3, exhibited behavior much like that reported by Holland—that is, the observing responses increased as signal time approached. The record of one subject, *S*-3, corresponds almost exactly to those presented by Holland.

The observing responses of the other three subjects, *S*-1, *S*-4, and *S*-5, were relatively continuous and unlike those obtained by Holland. This was particularly true of *S*-1.

While Holland found that the temporal manner of signal presentation controlled the observing behavior of subjects, the results of the present experiment indicate that this behavior differed between subjects under identical experimental conditions. Some subjects moved their head and eyes away from the display immediately after a signal and then fixed their eyes on the display again as the signal time approached. Other subjects apparently fixed their eyes on the display in a fairly continuous manner. The differences from Holland's results may be due to the measurement of a different response or to differences between subjects. It is also possible that the relatively continuous observing shown by *S*-1, *S*-4, and *S*-5 was due to the ease of the observing response. It has been shown (*3*) that there is no scallop in the observing rate curves for fixed-interval schedules when Holland's technique is used and when the key tensions are very light. However, the delays after detection and before responding increase with key tension.

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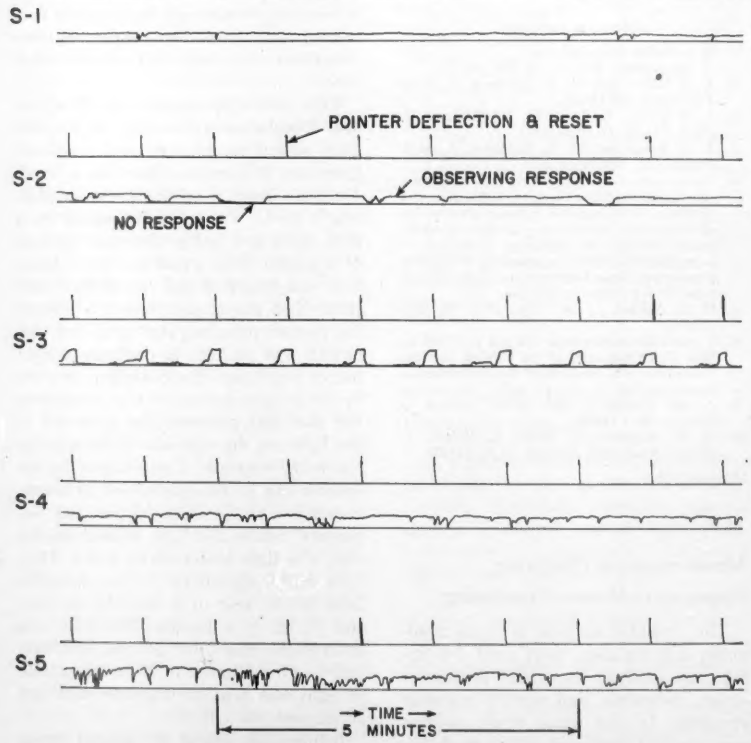


Fig. 1. Characteristic response records of each subject for a 1-minute fixed-interval schedule of pointer deflections. The records were obtained on the last (tenth) session.

#### References and Notes

1. J. G. Holland, *Science* **125**, 348 (1957).
2. B. F. Skinner, *Am. Scientist* **45**, 343 (1957).
3. J. G. Holland, personal communication.

6 March 1958

## Common Strontium Content of the Human Skeleton

The geochemical and biogeochemical behavior of the element strontium is important in understanding the movement of fission-product strontium-90 into man (*1*). Several investigators (*2*, *3*) have analyzed human bone from different locations for strontium. The availability of a large collection of bones from the study of world-wide fallout of strontium-90 made convenient the examination of this parameter in greater detail. This report (*4*) is concerned with (i) the distribution of strontium among the different bones in an individual skeleton, (ii) the distribution of strontium in the population of a single city, and (iii) the extension of information on geographical variation. Samples consisted of a variety of bones from eleven individuals, whole-skeleton ash from 133 New York City cadavers, and composites from 16 localities, each representing equal weights of bone ash from 4 to 38 individuals.

The analyses were performed by an emission spectrographic technique modified from that of Turekian and Kulp (*2*). The standards used to define the working curves were actual samples of bone ash which were analyzed by the isotope dilution method (accurate to within 5 percent). All samples were run in duplicate and are reported as parts of strontium per million. The reproducibility of these analyses is estimated to be about ± 10 percent.

The average strontium content of additional samples from previously investigated areas (*2*) was found to be about 30 percent lower. In order to check this discrepancy, some of the original samples were reanalyzed by the present method. The new analyses were also about 30 percent lower in each case. Synthetic standards similar to those used by Turekian and Kulp (*2*) were analyzed, using the present working curve defined by isotope dilution analyses of bone ash. The results indicate that a matrix dif-

ference between bones and chemically precipitated phosphate is responsible for the higher values reported in the earlier work (*2*). In view of this observation, the samples of Turekian and Kulp were composited by locality and redetermined.

The distribution of common strontium among the different bones of individuals was examined by analyzing the femur, tibia, fibula, humerus, ulna, radius, hand or foot bones, skull, pelvis-sternum, vertebrae, ribs, clavicle, scapula, and knee-elbow from eleven skeletons (*5*). Although the average strontium content of the whole skeleton varied by a factor of 3 among these individuals, there was no systematic difference in strontium content between any two bones of the body outside of the experimental error (standard deviation of 10 percent). Thus a single bone can give a valid estimate of the common strontium content of the body at this level of certainty. This would also be the case for strontium-90 distribution if a population ingested a diet with a constant $Sr^{90}/Ca$ ratio throughout the lifetime of the individuals.

Table 1. World survey of common strontium in human bone.

| Location | No. of samples | Sr in bone ash | |
|---|---|---|---|
| | | ppm | Av |
| *North America* | | | |
| Boston | 37 | 101 | |
| Boston | 38 | 109 | 105 |
| Boston | 62* | 117 | |
| New York | 134* | 162 | 162 |
| Houston | 14† | 125 | |
| Houston | 12 | 190 | 152 |
| Denver | 33† | 203 | 203 |
| Vancouver | 17† | 164 | |
| Vancouver | 12 | 117 | 144 |
| San Juan | 5† | 179 | 179 |
| Guatemala | 29 | 156 | 156 |
| *South America* | | | |
| Recife | 6† | 344 | 344 |
| Guayaquil | 17 | 179 | 179 |
| Cordoba | 18 | 160 | 160 |
| Santiago | 37† | 160 | |
| Santiago | 24 | 160 | 160 |
| Caracas | 37† | 187 | 187 |
| *Europe* | | | |
| West Germany | 30† | 137 | 137 |
| Copenhagen | 2† | 242 | |
| Copenhagen | 4 | 256 | 253 |
| Zurich | 1† | 140 | 140 |
| Rome | 9† | 160 | |
| Rome | 10 | 258 | 206 |
| London | 4† | 187 | |
| London | 21 | 156 | 160 |
| *Asia* | | | |
| Tokyo | 36 | 206 | |
| Tokyo | 21* | 199 | 206 |
| Tokyo | 5† | 203 | |
| Taiwan | 19† | 191 | |
| Taiwan | 6 | 179 | 187 |
| India | 30† | 176 | |
| India | 12 | 214 | 187 |
| *Africa* | | | |
| Durban | 13 | 195 | 195 |
| Liberia | 1 | 324 | 324 |
| World av | | | 172 |

* Samples run individually. † Samples reported by Turekian and Kulp (*2*) rerun as composites.

The histogram (Fig. 1) of the strontium concentration in 133 individuals (whole skeleton ash) from New York City shows a nearly normal distribution with a standard deviation that is only about ± 32 percent of the mean of 162 parts per million by weight. The narrow spread reflects the averaging of food sources in a city environment.

The data on the concentration of strontium in human bone in various geographical localities are summarized in Table 1. To show that the use of composite samples is valid, the samples from Boston and Tokyo were run individually, and then equal weights of bone ash were combined into composite samples. There appear to be small but significant differences from one locality to the next. The average for any given locality falls within a factor of 2 of the mean of the data (172 ppm). Recent work by Sowden and Stitch (*6*) on a limited number of samples from England analyzed by neutron activation gives results which are consistent within the experimental and natural variation of those reported here. Their work shows a lower strontium concentration in young children. This is expected as a result of fetal discrimination against strontium (*7*). An examination of the present analyses shows that for adults there is no age effect.

The average world-wide value of $(\%Sr)/(\%Ca) \times 10^3$ in human bone derived from Table 1 is $0.45 \pm 0.1$. The value $(\%Sr/\%Ca) \times 10^3$ in average rock or soil is $7 \pm 1$ (*8*). The discrimination factor between soil and skeleton for the strontium/calcium ratio is therefore $15 \pm 2$. The experimentally determined discrimination factor for strontium/calcium between soil and plant is about unity (*9*), between plant and milk, about 7 (*10*), and between milk or vegetation and human bone it is about 4 (*1*). Thus, if in the average urban world population, half of the calcium in the diet comes from milk, and half from vegetables, the predicted over-all discrimination factor would be 16. This figure is in good agreement with the geochemical value of $15 \pm 2$. If strontium-90 becomes uniformly mixed with the soil, as may occur in tilled fields, this factor will permit prediction of human bone level directly from soil analyses.

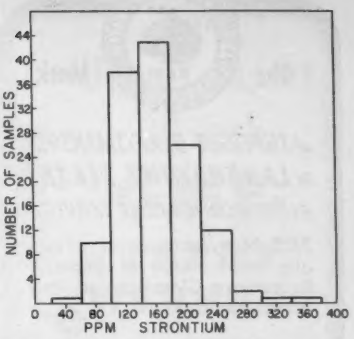


Fig. 1. Histogram of common strontium in ash of whole skeleton from New York City.

The relatively uniform distribution of common strontium in human bone reflects the uniformity in human diet. This observation means that variations in strontium/calcium ratios in different areas will not be an important factor in the distribution of strontium-90 from nuclear tests in the world's population.

D. L. Thurber, J. L. Kulp
E. Hodges, P. W. Gast
J. M. Wampler
*Lamont Geological Observatory, Columbia University, Palisades, New York*

### References and Notes

1. W. R. Eckelmann, J. L. Kulp, A. R. Schulert, *Science* 127, 266 (1958).
2. K. K. Turekian and J. L. Kulp, *Science* 124, 405 (1956).
3. R. M. Hodges *et al.*, *J. Biol. Chem.* 185, 518 (1950).
4. Lamont Geological Observatory contribution No. 304. This research was carried out under contract AT(30-1)-1656 between the U.S. Atomic Energy Commission and Columbia University. The criticisms and suggestions of Dr. K. K. Turekian are appreciated. We acknowledge the assistance of Mr. P. Hazlett.
5. A paper describing the details of this work is being prepared by A. R. Schulert, J. L. Kulp and E. Hodges.
6. E. M. Sowden and S. R. Stitch, *Biochem. J.* 67, 104 (1957).
7. C. L. Comar *et al.*, *Proc. Soc. Exptl. Biol. Med.* 88, 232 (1955).
8. K. K. Turekian and J. L. Kulp, *Geochim. et Cosmochim. Acta* 10, 245 (1956).
9. R. Menzel, private communication.
10. W. J. Visek *et al.*, *J. Dairy Sci.* 35, 783 (1952).

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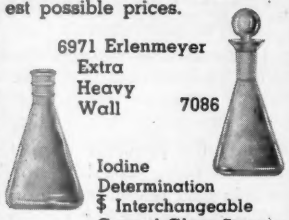

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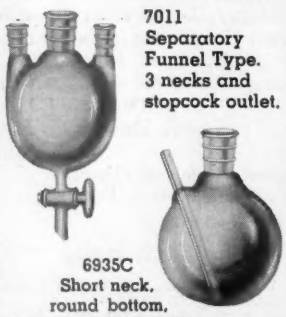

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# Meetings

## Oceanic Depths

The Centre National de la Recherche Scientifique of France invited some 15 foreign and 40 French scientists to attend the 83rd International Colloquium, in Nice. The topic chosen for the meeting was the topography and geology of oceanic depths. The largest foreign delegation came from the United States and included K. O. Emery and H. W. Menard from the west coast, R. Dietz of the London bureau of the Office of Naval Research, and W. Heezen from the east coast.

The papers that were presented fell into one of four categories, by topic: the Pacific Ocean, the Atlantic Ocean, the Mediterranean Sea, and papers of general interest. Among contributions that were centered around the Pacific and Indian oceans, the colloquium discussed the nature and origin of the continental borderland of Southern California, the distribution of flat abyssal zones, and the seismic structure of great depths. The renewal of deep waters in the Norwegian Sea added to the knowledge of the physics of dependencies of the Atlantic Ocean.

The Mediterranean was, of course, thoroughly represented among the studies, and, besides some new views on the morphology of the precontinent and tectonophysical characteristics, the age of the basin and the geology of the Tunisian-Sicilian unit came up for scrutiny. Of interest to geologists, biologists, and geographers was the study of deep-sea corals and Quaternary thanatocoenoses.

French contributions dealt mostly with studies pertaining to the Mediterranean, as did the Italian and Spanish papers. Of general interest is the news that the bathymetric-topographic map of the French Mediterranean is now complete except for a few gaps near Corsica, which will be filled this year by the *Calypso* expedition. To complete the map of the Mediterranean will require the lifting of restrictions by the Spanish government. The hope was expressed that such a move might be forthcoming.

The meeting at the International Hydrographic Bureau (Monaco) disclosed the current status of the World Hydrographic Map and brought us up to date on the work of the Commission of Nomenclature of Topographic Features of Oceans. A proposal was made for a series of terms in English and French. The possibilities of the use of television in submarine research were pointed out at the session in the Oceanographic Museum (Monaco).

Anglo-Saxon papers concentrated on studies done in the Atlantic, Pacific, and Indian oceans. The hope was expressed that information now being gathered by personnel of Lamont Geological Observatory might become available to all through a lifting of restrictive regulations now in force.

New bathyscaphes are being built, and the Belgians plan to produce one which would be able to plunge to the greatest oceanic depths. Most work done with these devices is done by the Americans and the French.

The meetings were climaxed by the inauguration of the new facilities of the Oceanographic Station of the University of Paris, at Villefranche sur Mer. Jacques Bourcart, geologist and oceanographer of the Sorbonne, is director and will spend one quarter of each year at the station. He expressed the hope that research people of all nations will not hesitate to make use of the laboratories.

The colloquium closed with a resolution that it will be necessary to call another meeting in the rather near future.

ROGER H. CHARLIER
*Station Océanographique de l'Université de Paris, Villefranche-sur-Mer, France*

## Meteoritical Society

The 21st meeting of the Meteoritical Society will be held 31 August and 1 September 1958, in Winslow, Ariz., and at the nearby Barringer Meteorite Crater. Scientific sessions, to which visitors will be welcome, will begin at 9:00 A.M. on 31 August at the La Posada Hotel. The field trip to the crater will be on the following day.

## Forthcoming Events

### August

*25–28.* American Soc. for Pharmacology and Experimental Therapeutics, Ann Arbor, Mich. (H. C. Hodge, Dept. of Pharmacology, Univ. of Rochester, Rochester, N.Y.)

*27–29.* Diseases in Nature Communicable to Man, 13th annual intern., Northwest conf., Hamilton, Montana. (W. L. Jellison, Natl. Microbiological Inst., Rocky Mountain Labs., USPHS, Hamilton.)

*27–3.* British Assoc. for the Advancement of Science, Glasgow, Scotland. (BAAS, Burlington House, London, W.1.)

*28–2.* Biometric Soc., ENAR, Ottawa, Ont., Canada. (T. W. Horner, General Mills, Inc., Minneapolis 1, Minn.)

*28–3.* Combustion Symp., 7th intern., London and Oxford, England. (Combustion Inst., 936A Union Trust Bldg., Pittsburgh 19, Pa.)

*31–6.* Housing and Town Planning, 24th cong., Liége, Belgium. (International Federation for Housing and Town Planning, Parkhotel, Molenstraat 53, The Hague, Netherlands.)

*31–8.* Corpuscular Photography Colloquium, 2nd intern. (by invitation), Montreal, Canada. (P. Demers, Institut de Physique, Université de Montreal, P.Q.)

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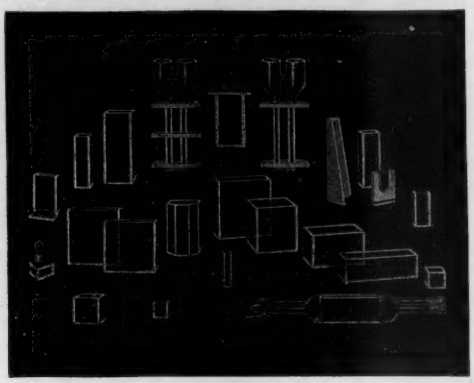

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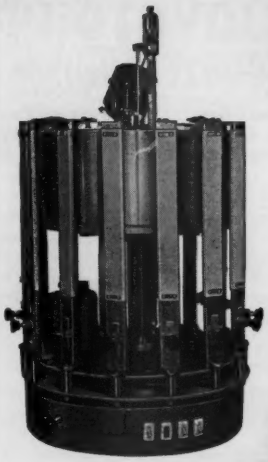

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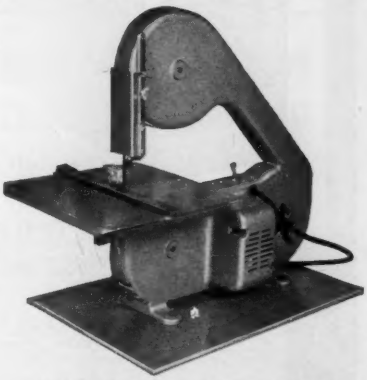

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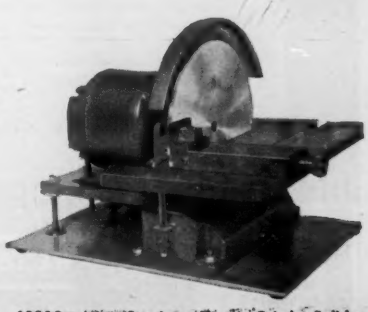

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### September

*1–6.* Biochemistry, 4th intern. cong., Vienna, Austria. (O. Hoffmann-Ostenhof, 1, Chemisches Institut der Universität, Währingerstrasse 42, Vienna IX.)

*1–7.* Psychotherapy, intern. cong., Barcelona, Spain. (M. de la Cruz, Clinica Psiquiatrica Universitaria, Facultad de Medicina, Barcelona.)

*1–9.* Analogy Computation, 2nd intern., Strasbourg, France. (F. H. Raymond, 138 Boulevard de Verdun, Courbevoie, Seine, France.)

*1–13.* Peaceful Uses of Atomic Energy, 2nd intern. conf., Geneva, Switzerland. (L. D. P. King, Atomic Energy Commission, Washington 25.)

*2–4.* Allergy, 4th European cong., London, England. (British Association of Allergists, St. Mary's Hospital, London, W.2.)

*2–4.* Vertebrate Phylogeny Symp., Soc. of Vertebrate Paleontology and Soc. for the Study of Evolution, Ann Arbor, Mich. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

*2–5.* Alaskan Science Conf., 9th, College. (R. L. Rausch, Alaska Div., AAAS, Box 960, Anchorage, Alaska.)

*2–5.* American Physiological Soc., 10th autumn, London, Ontario, Canada. (APS, 9650 Wisconsin Ave., Washington 14.)

*2–6.* Engineering Societies, Pan American Federation, 5th, Montreal, Canada. (L. A. Wright, Engineering Inst. of Canada, 2050 Mansfield St., Montreal 2.)

*2–6.* Glaucoma, intern. symp., Liége, Belgium. (R. Weekers, Clinique Ophtalmologique, Hôpital de Baviere, Liége.)

*3–5.* Cryogenic Engineering Conf., annual, Cambridge, Mass. (K. D. Timmerhaus, Chemical Engineering Dept., Univ. of Colorado, Boulder.)

*3–6.* Blood Transfusion, 7th intern. cong., Rome, Italy. (G. Marinone, Clinica Medica, Policlinico, Pavia, Italy.)

*3–10.* Cybernetics, 2nd intern. cong., Namur, Belgium. (Association Internationale de Cybernetique, 13, rue Basse-Marcelle, Namur.)

*4–5.* Air Pollution, 2nd intern, .conf., New York, N.Y. (American Soc. of Mechanical Engineers, 29 W. 39 St., New York 18.)

*4–6.* American Assoc. of Clinical Chemists, 10th annual, Iowa City, Iowa. (R. L. Dryer, Clinical Biochemistry Laboratory, State Univ. of Iowa, Iowa City.)

*4–6.* American Political Science Assoc., St. Louis, Mo. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington 6.)

*4–6.* Calorimetry Conf., 13th annual, Lemont and Chicago, Ill. (D. H. Andrews, Dept. of Chemistry, Johns Hopkins Univ., Baltimore, Md.)

*5–10.* Formal Deductive Systems in Mathematics and in Natural Science, symp., Brussels, Belgium. (International Union for the History and Philosophy of Science, 4, rue Thenard, Paris 5e, France.)

*5–13.* Tropical Medicine and Malaria, 6th intern. cong., Lisbon, Portugal. (M. R. Pinto, Instituto de Medicina Tropical, Lisbon.)

*6–12.* Pharmaceutical Sciences, 18th intern. cong., Brussels, Belgium. (J. W. Birza, 196 Bilderdijkstraat, Amsterdam W, Netherlands.)

*7–10.* Planetaria, symp., Bloomfield Hills, Mich. (J. A. Fowler, Cranbrook Inst. of Science, Bloomfield Hills.)

*7–11.* Diseases of the Chest, 5th intern. cong., Tokyo, Japan. (M. Kornfeld, American College of Chest Physicians, 112 Chestnut St., Chicago 11, Ill.)

*7–12.* Laurentian Hormone Conf., AAAS, annual, Blaney Park, Mich. (G. Pincus, 222 Maple Ave., Shrewsbury, Mass.)

*7–13.* Hematology, 7th intern. cong., Rome, Italy. (S. Haberman, Baylor Univ. Hospital, 3500 Gaston Ave., Dallas, Tex.)

*7–20.* Industrial Chemistry, 31st intern. cong., Liége, Belgium. (Society of Industrial Chemistry, 28, rue Saint Dominique, Paris 7e, France.)

*8–12.* Spectroscopy Colloquium, 7th intern., Liége, Belgium. (Association des Ingénieurs de l'Université de Liége, 22, rue Forgeur, Liége.)

*8–13.* International Council of Aeronautical Sciences, Madrid, Spain. (R. R. Dexter, Inst. of Aeronautical Sciences, 2 E. 64 St., New York 21.)

*8–17.* Sociology, 18th intern. cong., Nürnberg, Germany. (International Inst. of Sociology, Findelgasse 7–9, Nürnberg.)

*9–11.* Engineering Meteorology, 2nd natl. conf., Ann Arbor, Mich. (K. C. Spengler, American Meteorological Soc., 3 Joy St., Boston 8, Mass.)

*(See issue of 18 July for comprehensive list)*


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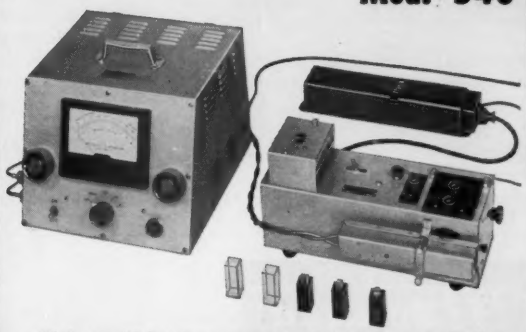

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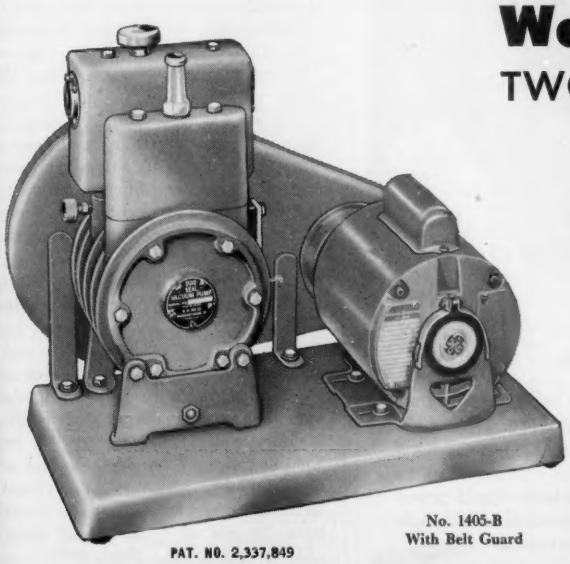

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■ RECORDER provides 44 or 68 channels of on-off information in two models. Marking is made on electrically sensitive paper. Five chart speeds from 2 to 32 in./hr are available. Actuation is accomplished by contact closure for each channel. (Lindly & Co., Dept. 214)

■ INFRARED CELL of effective path length up to 1600 m permits determination of air pollutants at concentrations less than 1 part per million. Ozone, carbon monoxide, or oxides of nitrogen or sulfide may be determined. Two cells are arranged to be used simultaneously, one in the sample beam and one in the reference beam of the manufacturer's model 21 spectrophotometer. (Perkin-Elmer Corp., Dept. 201)

■ ANNUNCIATOR for monitoring automatic systems uses static magnetic controls instead of relays. The magnetic elements are capable of the logic functions: and, not, or, and memory. A circuit can be included which will return the system to its previous state when power has been restored after a power failure. (Panellit, Inc., Dept. 197)

■ AUXILIARY RECORDER may be used with the manufacturer's infrared spectrophotometers to provide versatility in recording. Signals are picked up from the spectrophotometer by means of a potentiometer mounted on the instrument's pen-drive shaft. Three modes of operation permit recording of 100-percent transmittance, or any 10-percent transmittance or any 20-percent transmittance at full scale. A fourth mode permits 100-percent transmittance to be compressed for recording on punched cards. The recorder operates simultaneously with the built-in recorder of the instrument. (Baird-Atomic Inc., Dept. 202)

■ MICROWAVE AMPLIFIER for 2 to 4 kMcy/sec operation provides 1-w peak pulse power output at 30-db gain or 100 mw continuous-wave with 20-db gain. Connection is available for pulse modulation or automatic-gain-control applications. Gain may be controlled over a 30-db range. (Alfred Electronics, Dept. 187)

■ PYROMETER is a dual-range instrument for measurement of surface temperature. A low range, 0° to 500°F, and a high range, 0° to 1500°F, may be selected by a switch. Compensators are corrected automatically for changes in ambient temperature. Accuracy is ± 1.5 percent. (Pyrometer Instrument Co., Inc., Dept. 205)

■ VOLTMETER combines a laboratory-standard meter with a feedback multistage high-gain amplifier to provide accuracy of ± ¼ percent r.m.s. voltage measurement with 10-megohm input impedance. Voltage range is 0.002 to 500 r.m.s. Frequency response is constant from 50 to 2000 cy/sec. (Trio Laboratories, Inc., Dept. 207)

■ PULSE-CODE GENERATOR provides high-speed pulse programs at high impedance and high power output for study of memory components and digital logic. Ten-bit codes are provided at clock rates to 1 Mcy/sec with controllable repeat at selected intervals. Output is variable from 50 ma to 5 amp peak current. (Electro-Pulse, Inc., Dept. 208)

■ TORQUE TESTER measures torque in inch pounds and deflection in degrees for all types of torsion springs. A set of arbors and adapters permits a wide variety of sizes to be measured. Springs of wire size up to ⅛ in. diameter with torques from ½ in. oz to 48 in. lb can be checked. (Carlson Co., Dept. 209)


Packard

TRI-CARB*

LIQUID SCINTILLATION SPECTROMETER

MODEL 314X

**Completely Automatic . . . Simply Load 100 Samples and Read the Printed Data**

Count tritium, carbon-14, and other beta-emitting isotopes using less staff time than any other method. Model 314X provides all the advantages of TRI-CARB Liquid Scintillation Counting...*sensitivity, versatility, simplicity of operation and ease of sample preparation*...and does it automatically.

The Automatic TRI-CARB Spectrometer operates on the basis of both preset time and preset count. Counting is stopped by whichever is reached first. Sample number, time interval and two scaler readings are all printed out as an accurate and permanent record on paper tape.

For full information on the TRI-CARB Liquid Scintillation Method and detailed specifications on TRI-CARB Spectrometers, request latest bulletin.

*Trademark

Packard Instrument Company, Inc.

DEPT. A • P.O. BOX 428 • LA GRANGE, ILLINOIS

■ LOW-TEMPERATURE PROBES designed for measurement of temperature gradients in liquid oxygen provide output 0 to 5 v for a temperature span of 20°F in the liquid-oxygen range. Probes are also available for use with liquid argon, liquid nitrogen, or other liquids in the range from −240° to −320°F. Semiconductor sensing elements are used. Nominal resistance is 12 kohm, maximum current rating 3.0 ma, and calibration accuracy 0.1°F. (Arnoux Corporation, Dept. 188)

■ STROBOSCOPIC DEVICE may be used with a motion-picture camera to take slow-motion pictures of vibration tests with film running at normal speeds. The device combines a stroboscopic illuminator with a pulse-type camera synchronizer so that one exposure is made per frame. For viewing, the film is projected at normal speeds to display the same slow-motion effect as is provided by visual stroboscopic observation. (Chadwick-Helmuth Co., Dept. 212)

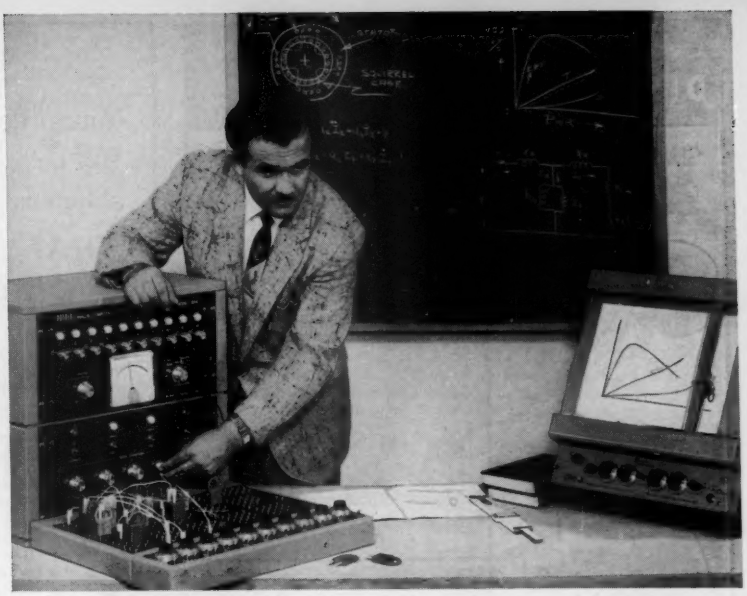
■ COULOMETRIC ANALYZER is a titration equipment in which a measured quantity of electricity is used to reach the end point of an analytical reaction. Results are read in digital form as micro-equivalents of the sample. Current is held constant within ±0.05 percent for line-voltage variation between 107 and 127 v a-c. (Leeds and Northrup Co., Dept. 213)

■ AMMETER, for ranges to 100 amp (d-c), provides accuracy of 0.2 percent. Ranges are selected by means of tapered plugs and holes. The instrument movement features diamond pivots and shock-mounted jewels. Scale is hand drawn 6.3 in. long and is mirrored to avoid parallax. Period is 1 sec. (Sensitive Research Instrument Corp., Dept. 216)

■ LIQUID DISPENSER delivers with reproducibility of ±0.15 percent with a glass system or 1.0 percent with a rubber system. The device may be set to operate in a continuous repetitive mode, 36 per minute, or for single deliveries. Volume to be delivered is adjustable to 12-ml capacity. (Fisher Scientific Co., Dept. 203)

■ FLOW VISUALIZATION APPARATUS uses petroleum fuel to generate smoke that is ejected from a manifold in equally spaced jets to produce a laminar pattern of alternate smoke and clean-air streams between two heavy glass plates. Models representing sections of structures to be studied are placed between the glass plates. The air streams can be adjusted in speed through a wide range. (Design Engineers, Dept. 204)

JOSHUA STERN
*National Bureau of Standards*

**Displaying induction motor performance graphically with the Donner Model 3000**

*The simultaneous equations describing the mesh currents in the induction motor equivalent circuit are used to create the computer programming schematic shown on the left hand side of the blackboard. The Donner Model 3000 Analog Computer solves the equations with an arbitrary choice of parameters and displays the solution on the oscilloscope or recorder. Shown on the recorder are traces representing torque, slip, and efficiency as a function of the power developed in a squirrel cage induction motor. Effects of parameter variations on motor performance are readily investigated and graphically displayed. The computer is also appropriate for study of transient recovery and polyphase motor or transformer fundamentals.*

# "Teaching Assistant"

## ELECTRICAL ENGINEERING

From the study of dc and ac circuit fundamentals through Laplace and Fourier transforms, teaching effectiveness in engineering can be expanded with the Donner Model 3000 Analog Computer. Serving as a veritable "Teaching Assistant," the Donner computer behaves as an arbitrary physical system. Solution to the describing equations is dynamically presented in visual form. Effects of variation in system parameters are quantitatively displayed with lasting impact.

A Donner analog computer can demonstrate dynamic system behavior in your classroom, multiplying the effectiveness in presenting new concepts in engineering. Without detailed knowledge of analog computers you can use the Model 3000 to demonstrate problems covering *DC and AC circuit fundamentals • steady state responses of networks and transmission lines • transient response of resonant and coupled circuits • simulation of rotating machinery • solution to complex networks • dynamic simulations of transfer functions • matrix analysis • frequency, phase, and time response • Fourier analysis • m-derived filters • autocorrelation and cross correlation • sampled data systems.*

For about $1500 you can put a complete computer to work in your classroom. Your students can establish a firm concept of the dynamic behavior of physical systems. A letter outlining your specific areas of interest addressed to Dr. V. B. Corey, Technical Director, Donner Scientific Company, Concord, California, will bring full details. **Dept. 508**

CALIBRATED **DISPENSERS** for Rapid and Repeated Delivery of Accurate Volumes of Liquid

SIMPLE TO USE

1. Tip back to fill reservoir.

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...accuracy to within ± 1%.

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- OVER 225 AMINO ACIDS
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- STEROID HORMONES
- BIOLOGICAL SALT MIXTURES
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**NUTRITIONAL BIOCHEMICALS CORPORATION**

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*Write For New Catalog May 1958 Over 2300 Items Write Dept. 102*

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**Replies to blind ads should be addressed as follows:**
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

## POSITIONS WANTED

**Biochemist**; Ph.D., biochemistry; minor, pharmacology; 4 years, clinical laboratory offices, USAF; 2 years, control chemist, industrial company. Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

**Botanist.** M.A. Bryology, taxonomy, ecology, Sigma Xi wants research position Washington, D.C. Box 184, SCIENCE. X

**Physiologist,** Ph.D. Specialized in physiology and pharmacology of pain. Desires research position. Box 185, SCIENCE. X

## POSITIONS WANTED

**Dental Scientist,** age 34 wants position of responsibility in dental engineering research. Academic background in dentistry and engineering; 7 years' engineering research and design experience. Box 183, SCIENCE. 8/8

**Virologist** Ph.D., veterinary-human virus interrelationships. Desires academic appointment. Box 181, SCIENCE. X

## POSITIONS OPEN

**Chemist or Postdoctoral Fellow** for basic research. Will interveiw at ACS meeting in September in Chicago. In reply give education, experience stressing techniques used. Academic institution in Chicago. Box 182, SCIENCE. X

**(a) Chemist;** M.S., Ph.D., experienced clinical chemistry to head active department, laboratory performing 150,000 determinations yearly; 270-bed southwestern hospital; to $7200. **(b) Bacteriologist;** hospital experience required to supervise section, 400-bed general hospital; midwestern university center; to $6000. **(c) Analytical Chemist;** M.S. or equivalent for supervisory position in pharmaceutical control; New England city 250,000. **(d) Bacteriologist;** degree; supervise well-staffed section, 300-bed Texas hospital; to $5400. **(e) Chemist;** M.S., Ph.D. experienced hospital chemistry; by four pathologists operating private laboratory, supervising several hospital laboratories; to $8000; Midwest. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

**Chemist,** male, with B.S. degree in organic chemistry or biochemistry, to participate in analytical biochemical research in mental illness in hospital near Philadelphia. Write stating age, education, experience, and salary desired to P.O. Box 8507, Philadelphia 1, Pa. 7/25; 8/1, 8, 15

## POSITIONS OPEN

**(a) Chemist** qualified in microbiology to direct research laboratory, major industrial company; university city, East; $10,000–$12,000. **(b) Chief Technologist,** 300-bed general hospital; expansion program; B.S., M.D., Ph.D., preferably in biochemistry; Michigan; $7000. **(c) Permanent Teaching and Research Appointment;** instructor or assistant professor; $7000–$8000; would be expected to teach neuroanatomy, gross anatomy, histology, and embryology; need not be expert in all but should be well qualified in at least two with working knowledge of other two. **(d) Medical Writer;** science degree, 1 or 2 years' experience required; duties involve helping to prepare articles for medical publications; important company; New York City; $8000–$9000. S8-1 Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

**NEW WORLD-WIDE GRADUATE AWARD DIRECTORY.** First compilation ever prepared for American scientists, teachers, and librarians to subsidize their education and research in more than 350 universities in 45 states, 30 foreign lands. Stipends $200–$10,000. Complete information. Just published. Send $2 now. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

**Nutritionist or Biochemist,** recent Ph.D. or equivalent. Position with research opportunity in Cancer Research Institute. Prefer nutrition background with experience and interest in biochemistry. Write and submit résumé to Department of Experimental Therapeutics, Roswell Park Memorial Institute, Buffalo, New York. X

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## POSITIONS OPEN

**Experienced Histology Technician,** ASCP registered preferred. Supervise histology laboratory in large midwestern teaching hospital, train technicians, opportunity for research. Box 163, SCIENCE. tf

**Medical Writer:** Leading eastern pharmaceutical manufacturer seeks experienced writer for full-time position to collaborate with clinical investigators in producing professional papers and exhibits. Send complete résumé including salary requirement. Box 174, SCIENCE. 8/1

**PHARMACOLOGIST**
**PHYSIOLOGIST**

**Ph.D. or equivalent with experience and interest in the cardiovascular and autonomic nervous system. To supervise and conduct research in the Cardiovascular Section of the Department of Pharmacology. Please submit résumé to**

**Personnel Department**
**The Wm. S. Merrell Company**
**Lockland Station**
**Cincinnati 15, Ohio**

**UNIVERSITY OF ALBERTA HOSPITAL**
**EDMONTON, ALBERTA, CANADA**

Applications are invited for the position of **Assistant Director of the Department of Clinical Laboratory Services.** The duties will be concerned with the future development of the biochemistry laboratory service in the hospital, consulting and advising on clinical problems and research projects involving biochemistry and teaching. A teaching appointment in the University of Alberta Medical School, while not automatic with this appointment, is customary. There will be ample opportunity to carry on individual research. The qualifications required are a degree in medicine and special training and experience in biochemistry. Preference will be given to those holding the M.R.C.P. or F.R.C.P. or a doctorate degree in biochemistry. Male, age 30–40 preferred but not essential. Salary $10,000–$12,000 per annum.

Interested parties should apply to the Medical Superintendent, University of Alberta Hospital, giving full details and the names of two references. 8/8, 15, 22

**Virologist-Immunologist:** New vaccine program of major eastern pharmaceutical manufacturer requires experienced virologist for research project team work involving close contact with laboratory scientists and field investigators. M.S. and some industrial experience desirable. Liberal benefits. Send complete résumé. Box 175, SCIENCE. 8/1

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By members of the staff of the National Cancer Institute, National Institutes of Health, U.S. Public Health Service

**Edited by FOREST RAY MOULTON**

7⅛" x 11½", double column, cloth, references, 20 tables, 52 illus. Published 1945—Now offered at reduced price

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**Your sets and files of scientific journals**

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

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**SWISS MICE**
***Price lists on request***
**DAN ROLFSMEYER CO.**
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**1 August 1958**

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**This coupon is for your convenience—to facilitate your requests for further information about advertised products and items in Equipment News.**

**From:**

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**Company** .....

**Street** .....

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(Please print or type)

**Mark, clip coupon — FOLD HERE along this line — mail**

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

**BUSINESS REPLY CARD**
First Class Permit #12711 New York, N.Y.

*Readers' Service*

**To: SCIENCE MAGAZINE**
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**Fasten Here Only**
**Staple, Tape, Glue**

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for
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George L. Rozsa, M.D.
143 Linwood Ave. Buffalo 9, New York

1 August 1958

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**Use this easy self-mailer to obtain further information about items or literature from the Equipment section as well as from advertised products.**

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**Circle below desired number corresponding to:**

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|---|---|---|---|---|---|---|---|
| 187 | 188 | 197 | 201 | 202 | 203 | 204 | 205 |
| 207 | 208 | 209 | 212 | 213 | 214 | 216 | |

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In list below, check page number of advertiser from whom you would like more information. If more than one item appears in ad, letters (A, B, C) are used to indicate particular items available in order of appearance in advertisement. Where more than one ad appears on page, **"U" indicates upper ad, "L" lower ad, "I" inside ad, "M" middle ad,** and **"O" outside ad.** Advertisements in Personnel Placement and Market Place are not keyed. A multiplicity of items is indicated by *. Readers are requested to specify on this coupon the particular item in which they are interested; otherwise, the request cannot be processed.

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|---|---|---|---|---|
| ☐ 222 | ☐ 223, A | ☐ 223, B | ☐ 223, C | ☐ 224 |
| ☐ 226 | ☐ 258, A | ☐ 258, B | ☐ 258, C | ☐ 259, UI |
| ☐ 259, UO | ☐ 259, L-A | ☐ 259, L-B | ☐ 260 | ☐ 261, UI* |
| ☐ 261, UO | ☐ 261, L* | ☐ 262 | ☐ 263 | ☐ 264, UO |
| ☐ 264, UI* | ☐ 268 | | | |

*2nd printing July 1957*

**THE FUTURE OF ARID LANDS**

**A symposium volume of the American Association for the Advancement of Science**

**Edited by Gilbert F. White**
Department of Geography, University of Chicago

**6 x 9 inches, 464 pages, 49 illustrations, index, clothbound, October 1956**

**Price $6.75. AAAS Members' prepaid order price $5.75**

The volume presents the efforts of scientists from 17 countries and from as many disciplines to assess the state of man's struggle to make productive and stable use of the world's arid lands.

It contains the papers and recommendations of the International Arid Lands Symposium and Conference, Albuquerque and Socorro, New Mexico, April and May 1955.

The symposium develops around a few basic questions. The representation and treatment of the subjects are highly interdisciplinary and lead to some important conclusions. The breadth and scope are indicated by the groupings of the Conference recommendations: Anthropology, Archaeology and Geography; Meteorology and Climatology; Hydrology, Geology and Soils; Biology, Ecology and Conservation; Organization, Communication, and Interdisciplinary Programs. Workers in all these fields, as well as administrators of government and private programs, will find the contents of this volume both stimulating for ideas and invaluable as a source of information.

"An extremely useful and stimulating assessment of the subject."

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# GET YOUR ADVANCE COPY

## of the General Program-Directory of the AAAS Washington Meeting by first class mail – early in December

The General Program-Directory of the 125th Meeting of the AAAS in Washington, D.C., Dec. 26–31, 1958, will be available to anyone, at cost, within the first week in December—whether he can attend the Meeting or not. You will want the General Program-Directory for your reference shelf.

**Program content**

1. The two-session general symposium, "Moving Frontiers of Science III: The Structure of Science and Scientific Organizations Abroad," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific Communication Problems.
3. Programs of the 18 AAAS sections (symposia and contributed papers).
4. Programs of the more than 90 participating societies.
5. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, Sigma Xi, RESA.
6. Details of the Sheraton-Park Hotel—center of the Meeting —and of the other hotels and session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1958 Annual Exposition of Science and Industry and descriptions of their exhibits.

**Directory content**

1. AAAS officers, staff, committees for 1958.
2. Complete roll of AAAS presidents and their fields.
3. The 279 affiliated organizations.
4. Historical sketch and organization of the Association; the Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

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**The following coupon may be used both by advance registrants and by those who wish only the advance copy of the General Program-Directory.**

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1b. ☐ Enclosed is $2.00 for only the Program-Directory. (It is understood that, if I should attend the Meeting later, the Badge—which is necessary for all privileges of the Meeting—will be secured for $1.00 more.)
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*for immediate shipment from our stock . . .*

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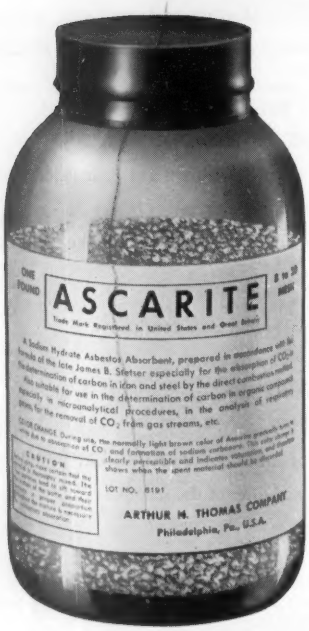


- **For more than 40 years the universally accepted standard $CO_2$ absorbent in the steel industry**
- **Also widely used in quantitative organic microanalysis, and in the analysis of respiratory gases, etc.**
- **Can be used in any absorption bulb designed for use with a solid absorbent**

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**ASCARITE®.** Prepared in accordance with the formula of the late James B. Stetser for the rapid and quantitative absorption of $CO_2$ in the determination of carbon in iron and steel and in universal use for this purpose in the steel industry; also used in carbon-hydrogen determinations, particularly in quantitative organic microanalysis, and in the analysis of respiratory gases, etc.

Can be used in any absorption bulb designed for use with a solid absorbent. For analytical work, an additional drying reagent is used following the Ascarite to absorb water evolved in the absorption of carbonic gases. For this purpose, we recommend Dehydrite, an anhydrous salt found to be highly effective.

NOTE—For bibliography on the use of Ascarite, see page 399 of our catalog.

| Mesh | 8 to 20 | 20 to 30 |
|---|---|---|
| **Per 1 lb.** bottle with plastic screw cap | **5.75** | **5.75** |

*5% discount in carton containing 12 × 1 lbs.*
*10% discount in lots of 48 × 1 lbs.*
*15% discount in lots of 144 × 1 lbs.*
} *one mesh or assorted, in carton units*

**COLOR CHANGE**

During use, the color of Ascarite, which is light brown in the original product, gradually turns to white due to the absorption of carbon dioxide and the formation of sodium carbonate. This color change occurs within a narrow zone and is clearly perceptible. Because of this marked difference in color between the used and unused portions of the absorbent, it is possible to determine when a bulb should be refilled.

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